Compressed Air Magazine

JUNE 1961

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HISTORY OF AN OLD IRON FURNACE
"WASA" RIDES THE WAVES AGAIN
A DRILLING COMPANY'S MAINTENANCE

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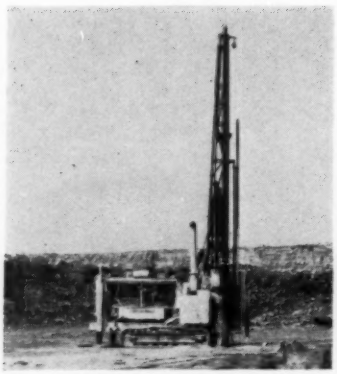

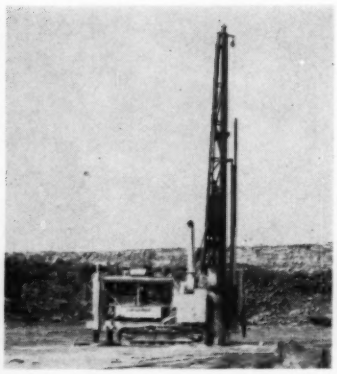

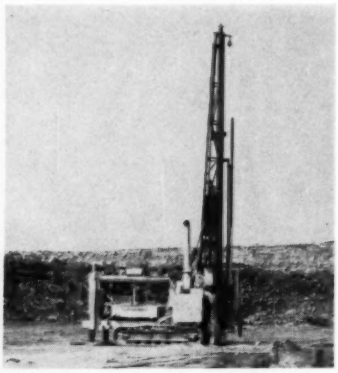

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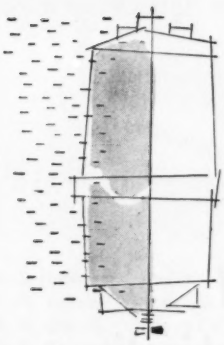

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FOR
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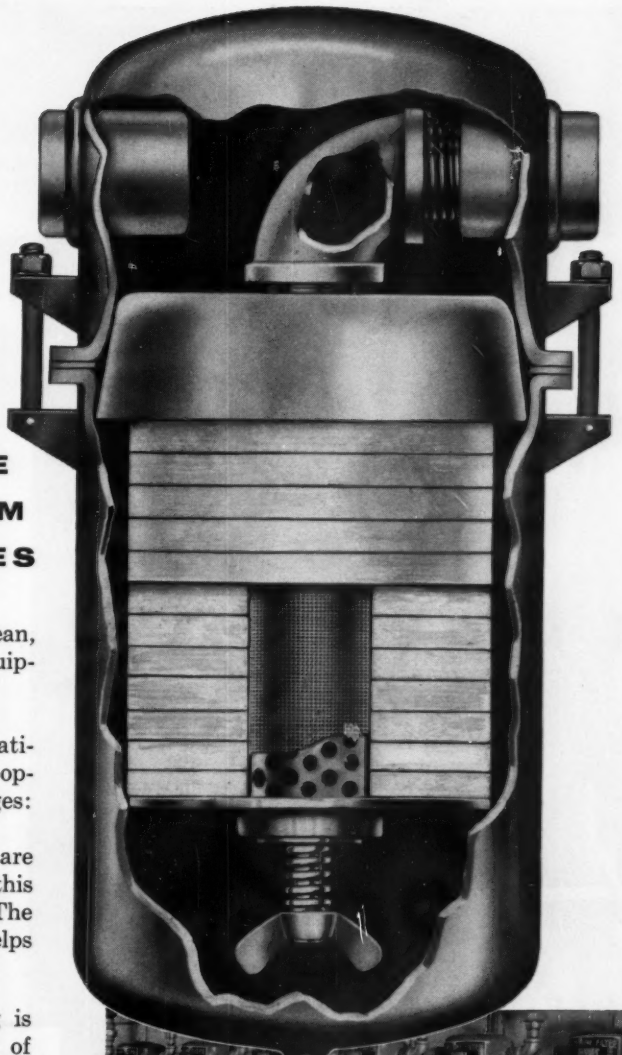

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Dollinger Staynew Filters keep air dry and clean, assure smooth operation of mechanical equipment despite constant change in humidity.

Model AAPHS Staynew Filters protect pneumatically-operated controls, instruments and air-operated tools. They offer a variety of advantages:

- Low resistance—heavier dirt particles are eliminated before the air itself is filtered; this prevents clogging of the filtering element. The result is low resistance to flow; this helps maintain line pressures, saves horsepower.
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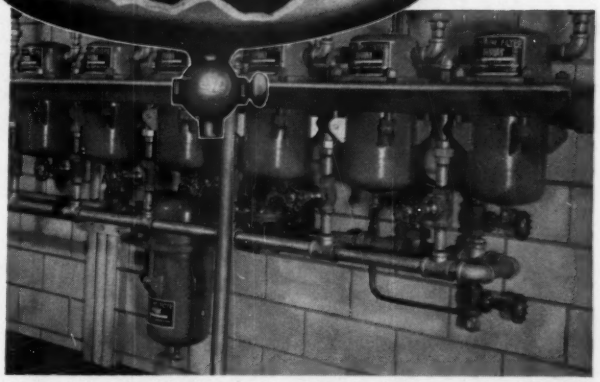
- Accessibility—interior parts are easily exposed for inspection and cleaning. Loosening of swing bolts permits removal of lower housing without breaking pipe connection.

For positive, trouble-free filtration, specify Dollinger. Call our representative nearest you, or write for Bulletin 200. Dollinger Corporation, Industrial Products Division, 7 Centre Park, Rochester 3, New York.



Part of an installation of 18 Staynew Filters protecting air-operated instruments in a power plant. Model AAPHS Filters operate effectively at pressures as high as 125 lbs. gauge.

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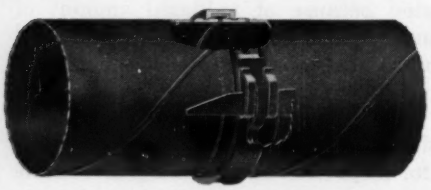
Contractors looking for ways to save time, work and money will like the way NAYLOR Spiralweld pipe and Wedgelock couplings team up to simplify and speed the job.

Light weight makes this pipe easy to handle, easier to install. The lock-seamed-spiralwelded structure adds the strength and safety you'd expect from heavy-wall pipe. The NAYLOR Wedgelock coupling saves time in installation because reliable connections can be made with only one side of the pipe in the open.

To simplify and speed your next job requiring air, water or ventilating lines, look into this pipe and coupling combination. Just ask for Bulletin No. 59.



NAYLOR Wedgelock couplings make a positive connection securely anchored in standard weight grooved ends. A hammer is the only tool required to connect or disconnect the coupling.

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Volume 66 Number 6

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on the cover

Summer heralds the auto racing season throughout the world and enthusiasts eagerly follow large and small competitions. This picture shows a sports car punishing its tires in a sharp hill-climb turn. Besides riding on tires filled with air, this driver sits on an air cushion (see page 15). There are more than 100 million cars, trucks and buses in the world, all but a tiny percentage running on air-filled tires. Replacements for passenger cars in the U. S. alone are expected to number 72 million units this year.

8 Maintaining A Steel Plant—R. J. Nemmers

Work goes faster, down time is reduced and direct labor costs are pared when air tools help in steel-mill maintenance. A series of pictures show air tools in action for Kaiser Steel's integrated works at Fontana, Calif.

18 Hopewell Village—C. H. Vivian

Early iron furnaces supplied colonists with much needed metal and were the forebears of today's steel industry. This article gives a detailed history of a furnace located in Berks County, Pa., that is now a national historic site.

26 The Good Ship "Wasa"

After 3 centuries at the bottom of Stockholm Harbor, the man-of-war rides the surface again. In remarkably good condition for her age, she may be the oldest vessel afloat.

28 From Planned Maintenance

A regular method of preventive maintenance keeps New Jersey Drilling Company's rigs operating efficiently, thereby holding customer confidence.

30 Simple Pipe Joints

How careful selection of pipe connections saved a company many production dollars and man-hours.

DEPARTMENTS

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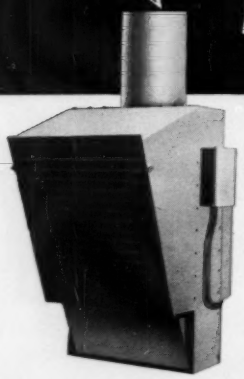
Reduce maintenance...increase equipment life

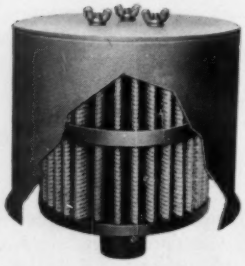
with

AIR-MAZE FILTERS

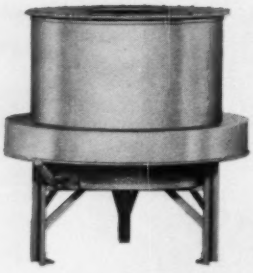
There's one to meet every need!



AIR-MAZE AUTOMAZE—the automatic, self-cleaning impingement type filter for heavy-duty use. A constantly moving curtain of viscous-coated double filter panels traps air-borne particles. Panels are thoroughly cleaned and recoated by passing through an adhesive bath. Filters consist of layers of crimped galvanized steel wire screens of selected meshes. Available in all capacities with or without weather louvres or plenums. Air or electric drive optional.



AIR-MAZE "DA" DRY-TYPE FILTER—laboratory tested for better than 98% efficiency with particles of 2 micron mean diameter, practically 100% with particles 5 microns or larger. Corrosion resistant, designed for use up to 6650 cfm. Filter media is heavy, deep-pleated wool felt flanked by sturdy galvanized steel cloth. Element can be cleaned with a commercial solvent or by blowing off with compressed air.



AIR-MAZE OIL BATH FILTER—the low-pressure-loss way to oil wash intake air. Offers a distinct engineering advancement because it provides low static pressure drop without requiring any outside energy. Removes practically all fine abrasives and dirt! No moving parts, nothing to wear out, easier servicing! Made of rugged, heavy gauge steel coated with enamel. Available in capacities up to 20,000 cfm.

Write for latest bulletins on AIR-MAZE complete line of air and liquid filters and intake silencers for all types of large engines and compressors.

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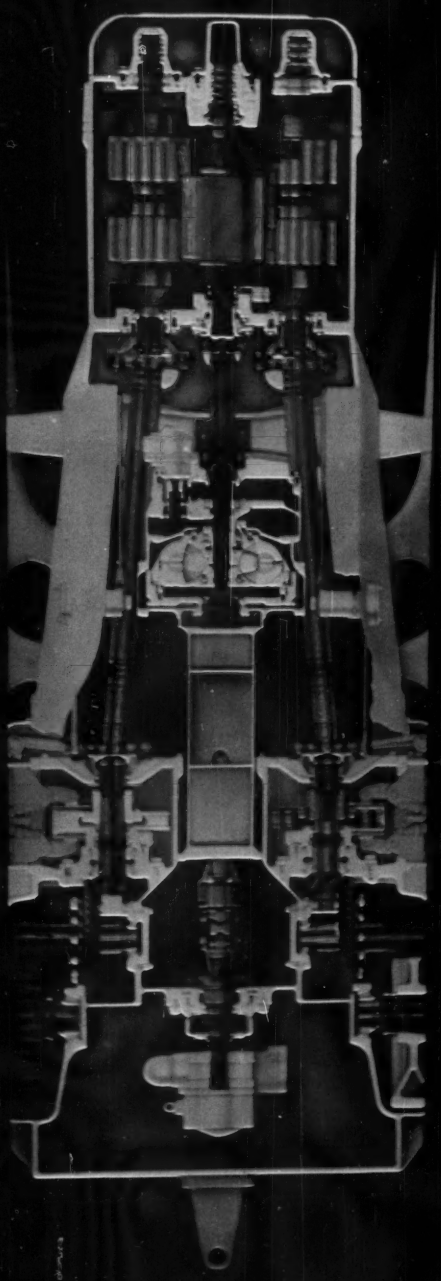

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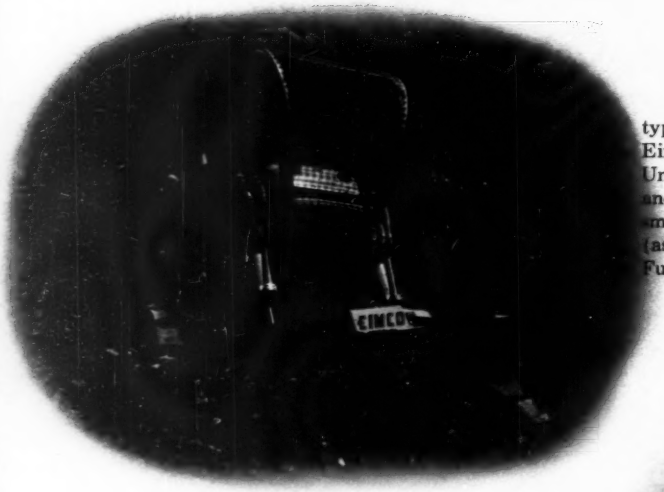
Turn the page for additional facts and pictures on the dependable Eimco Line of Tractors....



Eimco Dozers, available in three series of sizes and all types of blades, including Tilting-Angling. Shown here is the Eimco 103 Hydraulic Angle Dozer, built with Eimco's famous Unitized "Stress Flow" Construction. Extra strength, service-life and rigidity, because there are no welds, no bolts . . . just a smooth, strong flow of steel in the main frame and underside (as shown on the cover picture) and in the loader bucket arms. Full track oscillation, with all attachments, for working stability.

The Eimco 126 Front End Loader, (shown) with 205 HP Diesel engine, will outwork, outload, outproduce and outlast far larger and more expensive equipment. Compact and powerful, with weight centered where it means the most in workability, this series is made in all types of dozers, front end loaders, log loaders and as a special steel mill front end loader.

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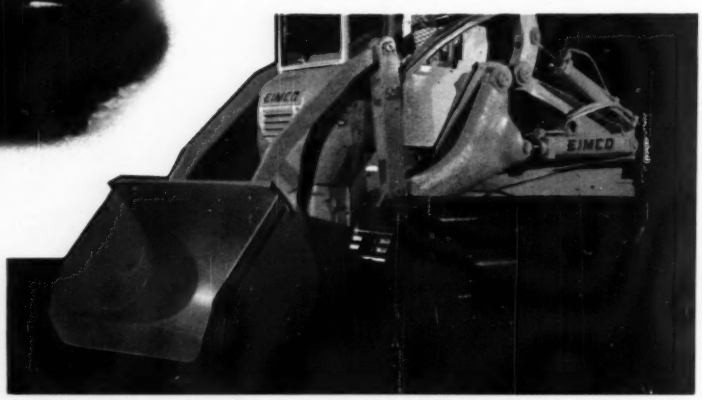

Compare the strength and size of the Eimco "Stress Flow" cast steel arms . . . of the cylinders and pins . . . the quality construction of the Eimco Front End Loaders with any other equipment and you'll agree "You can't beat an Eimco!"

See your nearby Eimco Dealer, Warehouse or Branch and check the facts on modern crawler construction, quality, work-ability. Or write for illustrated booklets and specifications to THE EIMCO CORPORATION, Dept. IN., P.O. Box 300, Salt Lake City 10, Utah, U.S.A.

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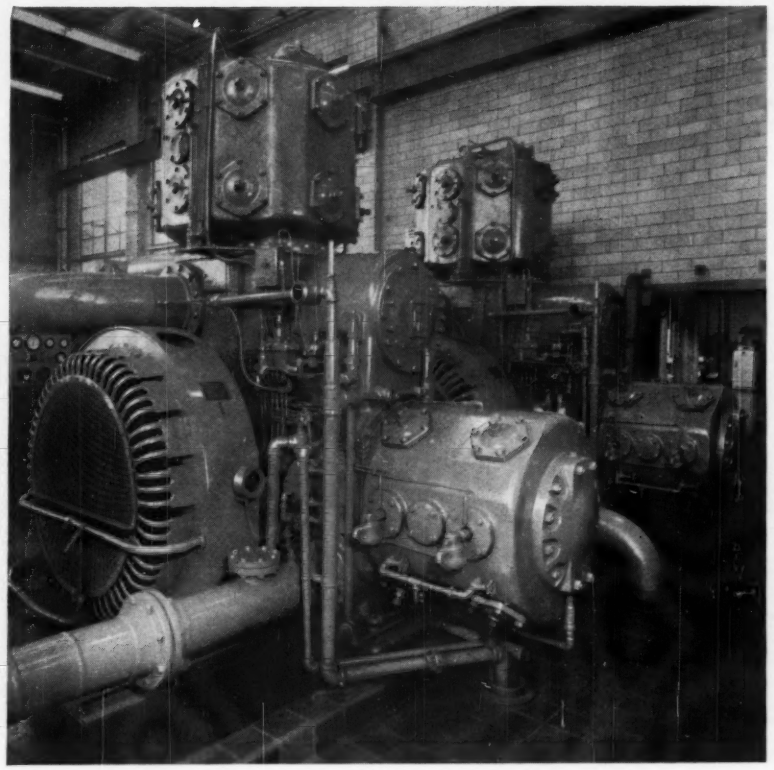

IN I-R COMPRESSORS,

TIME TELLS

THE DIFFERENCE

In these two XLE compressors, 21 Channel Valves have operated

45,482 HOURS

with no parts replaced!

The two Ingersoll-Rand XLE air compressors shown above are installed at a large midwestern automotive plant. They were started up in May, 1951, and at this writing have totalled 45,482 hours, mostly at 16 to 24 hours a day.

Of the 28 Channel Valves (14 per unit), 21 have operated full time with *no repairs*, merely being cleaned once a year. Each of the other seven valves had only one channel and spring replaced in all this time, during the scheduled inspection period. And all the valves are operating with their seat plates still on the first side—when the plates are turned over, their life will be doubled.*

The *extra value* that's built into every type of Ingersoll-Rand compressor pays off with *long-run economy*. Reduced maintenance and attention, over many years, mean long-range savings in the cost of air power. Ask your I-R representative for more information on the world's most complete line of compressors—in reciprocating, centrifugal, axial-flow, rotary and thermal types. There are units from ½ to 25,000 hp, for pressures from one micron to 125,000 psi. Call him now.

***Only I-R compressors have Channel Valves**
Known for high efficiency, quiet operation and exceptional durability. Entirely different. Each valve is a combination of rigid stainless-steel channels and bowed leaf springs, with trapped-air spaces which cushion action, prevent impact.

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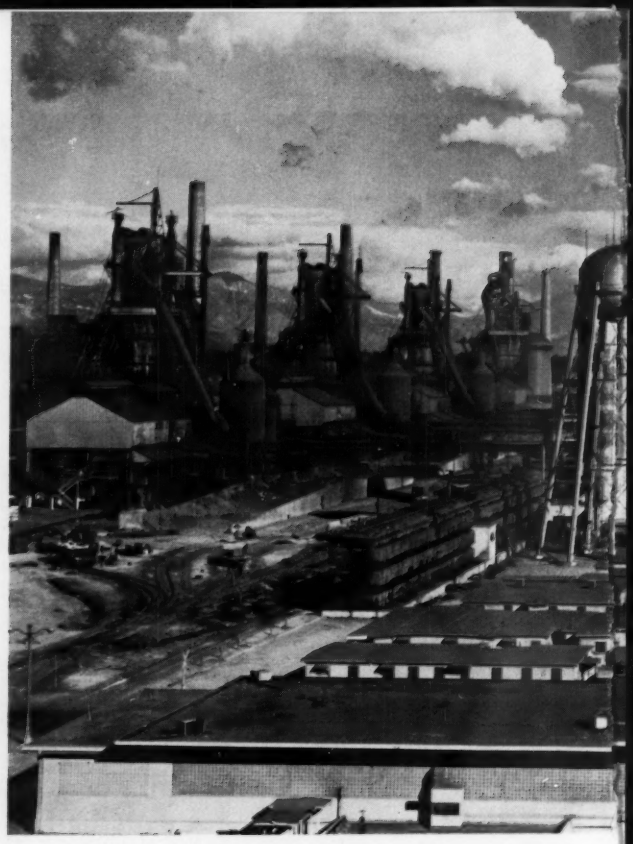


MILL CENTER The four Kaiser blast furnaces are shown at the left in this view of the mill. They are the only ones on the West Coast. At the right are the stacks of the nine open hearth furnaces.

R. J. NEMMERS

MAINTAINING A STEEL PLANT

THE 34.7 million tons of steel that rolled from the nation's mills in the first quarter of 1960 was a record amount for any like interval. During that period, the approach of steelmen to maintenance was to do it thoroughly and to do it quickly. The concept is easily understood. The pipelines of steel supply were empty, customers were running short or had even curtailed operations for want of steel. For a short time the rule was that if steel could be made, it could be sold.

The remaining quarters of 1960 weren't so good. Production was sharply curtailed. The maintenance concept didn't change, however. The rule read: "customers know steel is plentiful, that their money need not be tied up in inventory, that suppliers will compete for their business not only from the standpoint of price, but of delivery."

It is possible to draw the wrong implications from such a concept. Steelmen don't like "put out the fire" maintenance programs. Fundamentally such programs are wrong. They cost more in direct charges, more in lost production. Thus maintenance in the steel plant becomes a planned program that is continuous through good times and bad. (Even idle equipment requires some maintenance.)

New methods, new processes have drastically altered many steelmaking concepts in the post war years, and investment in new plant and equipment has been high. From 1946 through 1960, $13.8 billion was put into expansion and rehabilitation programs. Last year, although a bad one from a sales standpoint, nearly $1.5 billion was laid out for improvements and expansion, a total second only to 1957's $1.7 billion. This year an estimated $1.2 billion will be spent.

These almost incredible sums of money are hard to come by. They are obtained in part out of profits when competition at home and abroad is stiffer than ever before. They come in part from stock and bond sales in competition with other industries whose growth rate and rate of return are equivalent, and in some cases better than that, of steel. Part is obtained from depreciation allowances set up when the dollar was worth considerably more than it is today.

Taking all things into consideration, there is little that is not self-apparent in the fact that steel maintenance practices must have grown and developed to meet the challenge of taking good care of expensive equipment. Such things as lubrication methods have received close scrutiny. Few breakdowns occur that are not traced to their origins so that corrections can be made rather than just repairs. New, longer lasting materials are used in replacement parts when they will be of benefit, and even long-standing operating practices are changed when it can be proved that the change will add to the life of equipment.

Inevitably, however, the time must come when a piece of equipment must be shut down and worked on. The philosophy of planned maintenance is that this be done at a time when production workers are not idly standing by waiting for the repairs to be made, at a time when production from the machine is not being counted on for fulfillment of an important order. Even with planning, however, it is still necessary that the equipment be returned to service rapidly, that down time be held to a minimum and that the actual out-of-pocket cost of maintenance itself does not get out of hand.

Pneumatic tools have come to play an important role in steel plant maintenance. They speed work, cutting down time and direct labor costs. They make it possible to do a thorough job by providing the time to adequately inspect other related parts that may also be worn and in need of replacement. They are light in weight and can be easily toted into tight corners. They can be overloaded to a stall without damage and are unaffected by hot, dirty, wet or greasy surroundings. They may be used safely under almost all conditions.

On the following pages is a picture story showing typical air tool maintenance applications in Kaiser Steel's Fontana (Calif.) works.

KAISER's Fontana plant is typical in some respects, in others it is atypical. It enjoyed good sales the first quarter of 1960. Later quarters saw production sharply curtailed. Immediately after the war it had a close-by market virtually to itself. Today it faces stiff competition not only from other nearby producers, but from foreign steel as well.

The postwar return to normalcy for Kaiser was considerably different from most steel companies. The firm had never known "normalcy." Conceived and built in 1942 for the one purpose of making war material, it incorporated in its original design (especially in the mill shops) certain features that were all together suited to meet emergency conditions, but which were not well adapted to postwar competition in the free market. Kaiser met these problems with well-planned expansion programs that eventually raised its output to 2,933,000 ingot tons. These programs included steps to increase efficiency and provide some operating versatility to meet consumer demands. The total cost of the latest was $212 million.

A large part of the money spent by Kaiser at Fontana went into equipment to make it a good neighbor to the surrounding orange groves, vineyards and truck farms. That the plant makes almost no contribution to the smog that plagues the area is due to some painstaking research on the part of Kaiser engineering and research staffs and the expenditure of about $15 million.

Kaiser is certainly unique in that flowers and trees survive within the plant confines. Although other steel companies are now paying more attention to combating air pollutants, the Fontana plant is years ahead.

The Fontana works is a completely integrated steelmaking operation. Kaiser's own Eagle Mountain mine is 163 miles away in Southern California. The majority of the company's iron ore is supplied by this mine. Coal comes from Sunnyside Mine in Utah and from the Raton Mine in New Mexico, both company-operated sources, and from other mines in the Midwest and Southwest. Limestone comes from one Kaiser-Steel-owned, Permanente-Cement-Company-operated quarry at Cushenberry, Calif., and outside sources in Nevada.

The major items of equipment at Fontana are shown in the accompanying tables. A glance at them also gives some idea of the products turned out at the plant. When operating at normal rates, about 8000 people are employed. Ground was broken for the Fontana plant just 19 years ago in April 1942. The first cast of blast furnace iron was made in December of that year and the first heat of steel from an open hearth was tapped the following May.

FONTANA WORKS IRON AND STEEL EQUIPMENT

BLAST FURNACES (iron)

Furnace No.	Capacity (tons)	Installed (year)	Hearth Diameter (feet)	Average Blast Volume (cfm)
1	1300	1942	27	70,560
2	1300	1949	27	70,560
3	1300	1953	27	70,560
4	1750	1958	29½	85,000

BLOWER PLANT (total for all furnaces)

Machines (no.)	Capacity (cfm)	Pressure (psig)
2	100,000	30
2	75,000	35
1	115,000	35

BASIC OXYGEN FURNACES (steel)

Units (no.)	Capacity (tons)	Installed (year)	Charge	Lance Diameter (inches)	Lance Hoists
3	110 each	1958	molten blast furnace iron, scrap	6	electric with stand-by air

OPEN HEARTH FURNACES (steel)

Units (no.)	Capacity (tons)	Installed (year)	Charge	Hearth Area (sq. ft.)	Fuel	Regenerators
6	185 each	1943	molten blast furnace iron, scrap	850	oil	2 each, single pass
3	200 each	'48, '51, '53	molten blast furnace iron, scrap	927	oil	2 each, single pass

FONTANA WORKS MILL EQUIPMENT

Mill Type	Size (inches)	Installed	Finished Metal Thickness (inches)	Width (inches)	Length (feet)
Slabbing	46 to 90	1958	4 to 12	20 to 72	6 to 22
Blooming	46	1946	4 to 10 (slabs) 5 to 10 (blooms)	36 5 to 17	5 to 18
			Other products: 8-inch H-beams; 10-inch wide flange beams; 12- to 20-inch I, or channel beam blanks		
Plate	148	1943*	3/16 to 4	36 to 126	60 (max)
Structural	29	1944	½ to 1½ (universal mill plate) 3 (slabs)	7 to 16 5 to 16½	
			Other products: 5- to 18-inch channels; 4- to 20-inch i-beams; Rounds, 4½, 5 and 5½ inches; Angles, 3½x3½ to 8x8 inches and 3x4 to 4x9 inches		

MERCHANT AND SKELP MILL

Product	Thickness (inches)	Width (inches)	Product	Dimensions (inches)
Skelp	0.100 to 0.230	4½ to 15¾	Rounds	17/32 to 4¼
Flats	0.104 to 0.375	6 to 16⅜	Squares	17/32 to 4¼
Round edge flats	0.214 to 1.000	1¾ to 6	Channels	3 to 4

ELECTRIC WELD PIPE MILL — Annual capacity: 292,000 tons
4½ to 12¾ inches in diameter; 0.188 to 0.406 inch wall thickness

CONTINUOUS WELD PIPE MILL — Annual capacity: 120,000 tons
½ to 4 inches in diameter; 0.100 to 0.329 inch wall thickness

COLD ROLLING MILL — Annual capacity: 36,000 tons
Strip metal: 0.016 to 0.122 inch thickness: 10⅜ to 19½ inches (unslit) wide
1 to 19 inches (slit) wide

HOT STRIP MILL — Annual capacity: 1,500,000 tons
Strip metal: 0.048 to 0.355 inch thickness; 24 to 72 inches wide

TIN PLATE MILL — Annual capacity: 441,000 tons
Hot dip sheets: 0.024x34x40 inches (max)
Electrolytic coils: 0.0071 to 0.0141 inches gauge and 24 to 36 inches wide

* Originally installed in 1943, expanded to 148-inch mill in 1958

FURNACE GAS CLEANING APPARATUS

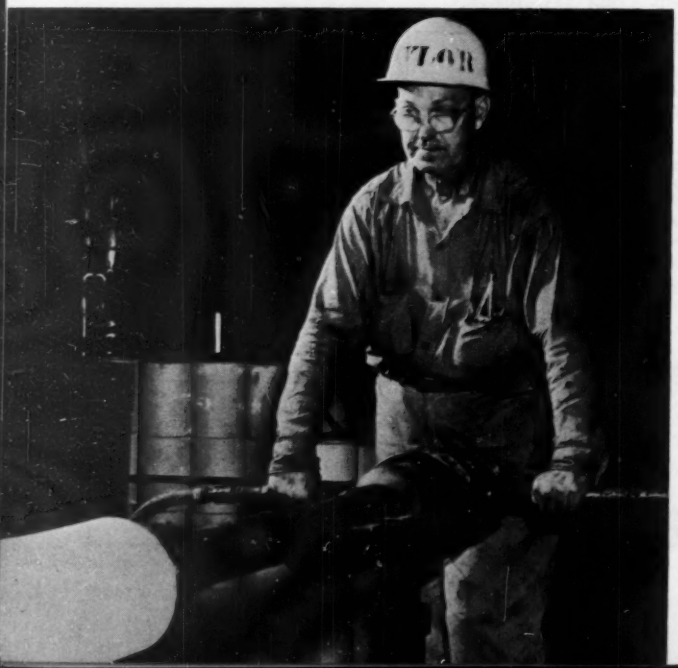
(Air Pollution Control)*

BLAST FURNACES Each is equipped with a dust catcher, a washer and two wet electrostatic precipitators.

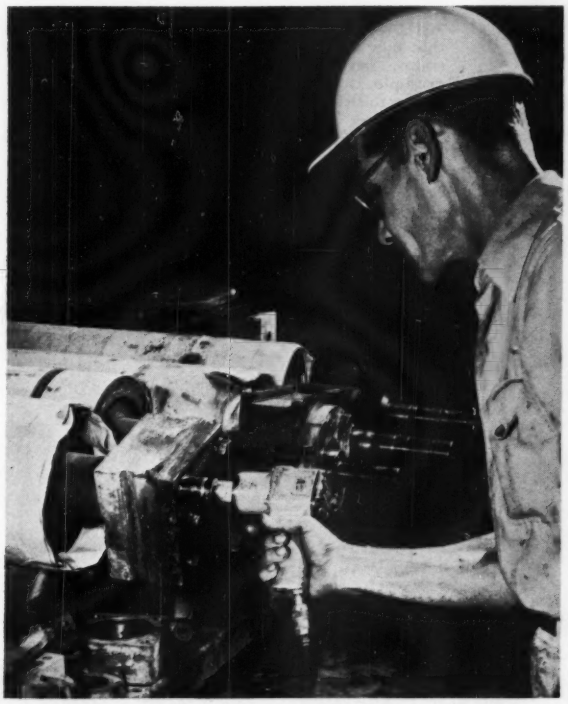
OPEN HEARTH FURNACES Eight of the nine furnaces each have 5-section dry electrostatic precipitators, three of the sections being energized. Ninth furnace has 2-section unit. Latter was first and experimental installation. Efficiency approaches 95-percent removal of all particulate matter.

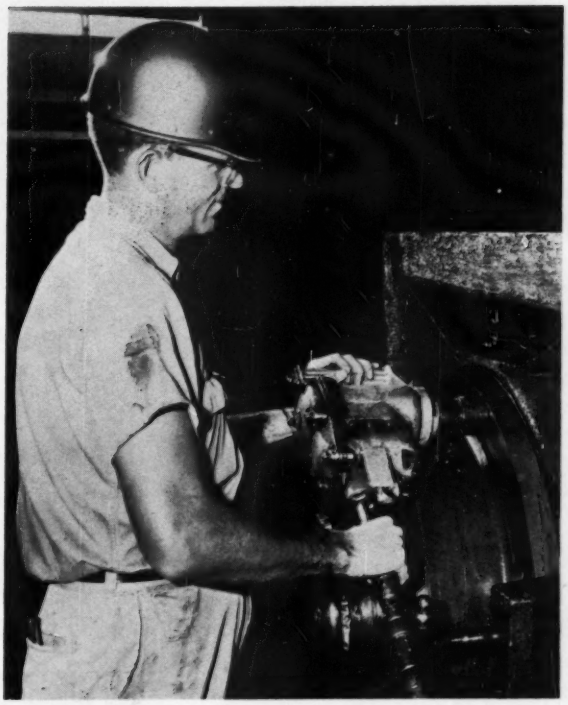
OXYGEN FURNACES Most difficult of all gas cleaning jobs as about 3 percent of total charge is given off as dust and fume. Each furnace is blown for 25 to 30 minutes, then shut down, then blown for shorter interval. Temperatures vary widely and rapidly. Gas from each furnace is cooled with water, then receives injection of live steam to change resistivity. Gas flow is about 400,000 cfm through two precipitators (a third for each furnace is on stand-by). Velocities are low, detention time, relatively long as dust is exceptionally fine. Precipitate is reclaimed in sinter plant.

* Note: San Bernardino County regulations specify that no more than 48 pounds per hour of particulate contaminants shall be emitted for any single large operation such as a blast furnace. Kaiser aims at 40 pounds as a practical working level.



STOPPER RODS Ladles in the open hearth are tapped from the bottom. Until tapping, the necessary holes are plugged with stopper rods that pass through the molten steel into the hole. They are repaired after each heat. The rods are made up of a 2¼-inch-diameter rod over which tubular sections of refractory tile are placed. As many as 20 tiles and a carbon end block go into a built-up rod. When all are in place (cement is used between each section and its mate), a plate and nut are placed on the end of the rod and the nut run up tightly to clamp the sections securely. A Size 577 Impact Wrench, in a special mounting, is used for this duty, as shown in the picture at the left. Completed stopper rods are handled by the Size B overhead air motor hoist as shown in the picture of assembled rods at the right. The 1000-pound capacity Ingersoll-Rand hoist has a motor-driven trolley. A large number of these durable hoists are installed in the plant for such applications as roll handling, etc., where the advantages of the precision control of pneumatic hoists are most valuable.

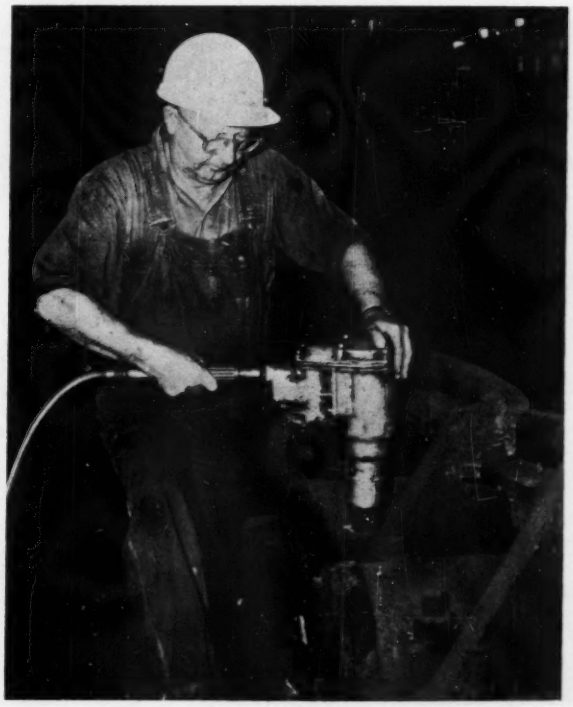




ROLL MAINTENANCE The impact of steel on steel, sometimes at red heat temperature, is a hallmark of steel mill operations. Giant ingots slam into rolls and are squashed and squeezed into a variety of shapes. The rolls and their bearings are thus subject to the most severe operating conditions encountered almost anywhere. For the turning and finishing of rolls there are four shops scattered throughout the plant. In the main shop are eight lathes and two roll grinders of varying sizes; at the plate mill, one lathe and one grinder; at the strip mill roll shop, three grinders; and at the tin plate mill, six grinders. At least two sets of rolls are available so that mills need be down only the length of time necessary for the rolls to be changed—a job considerably speeded by the use of pneumatic tools.

Some rolls, such as those used in the finishing stands for black (uncoated) plate in the tin mill, are highly polished. As shown at top left, these are wrapped in heavy paper to protect them until installed. Rolls such as these that are adjustable in the stands are mounted in bearing blocks. An Ingersoll-Rand Size 804 Impactool does that job.

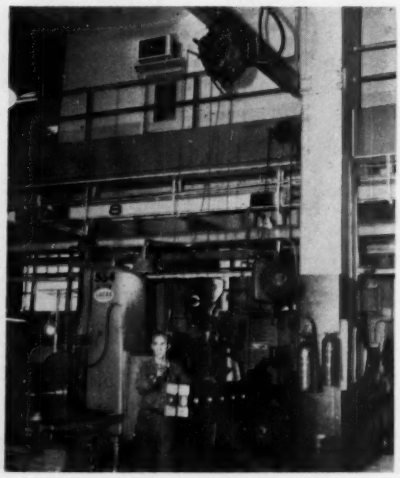
The bigger the roll, the bigger the tool might well be a rule of roll maintenance. The two pictures at the right show 538 Impact Wrenches in use. The one at the top is working on a back-up roll on the tinplate temper mill. The one below is working on table roll bearings on the 46-inch blooming mill. On the blooming mill roll line, an even bigger tool comes into play. The wrench shown in the picture at the lower left is a Size 577.



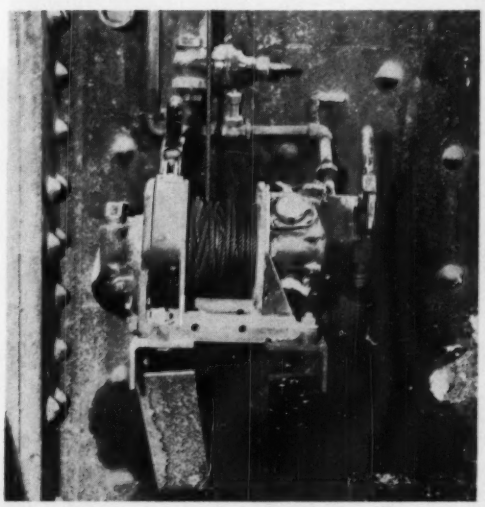
PINION STAND Other sections of the mills that take a terrific beating are the power trains. On the 46-inch blooming mill, for example, it takes a 5000-hp variable speed d-c motor to drive the 38-inch diameter mill rolls. The power train is made up of 46-inch pinions. Shown in this picture is the biggest pneumatic tool in the plant—an Ingersoll-Rand Size 588 Impact Wrench—that easily handles the out-sized nuts on the pinion stand. They measure $7\frac{1}{2}$ inches across the flats. The tool weighs 215 pounds bare and is lifted into place by any shop crane available for service work. Without this tool, time-consuming sledging of the nuts would be required both for removal and replacement. The Impactool not only saves time, it eliminates the hazards of hand sledging the heavy nuts.

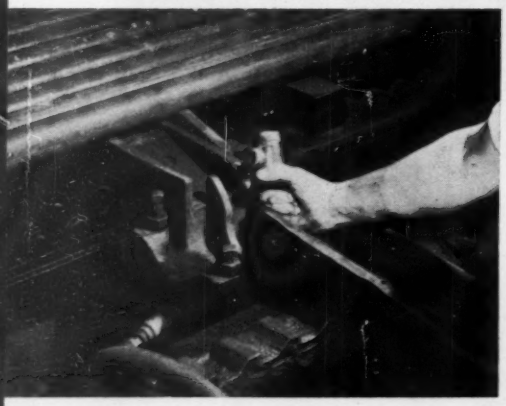
TIGHT CORNERS Air tools are smaller and lighter in weight than any other power tools for the same power. Single hand operation is often possible. An additional advantage is that they can be equipped with angle heads or other attachments to make them more suitable for getting into tight corners. One good example of the close-quarter work possible is shown here. The job is the removal and application of water hose clamps on the electrostatic precipitators that serve one of the basic oxygen steelmaking furnaces. The angle wrench is an Ingersoll-Rand Size OBR1N with an OAC9 head.

TO CHIP AND LIFT Maintenance tasks assigned to air power aren't confined to running and loosening nuts and screws. These two pictures show other common uses. The one at the left shows a boilermaker cleaning up and beveling the edge of a sheave guard with a Size 1 chipping hammer. In the machine shop (right), one of several Size C overhead air motor hoists handles heavy lifting jobs.

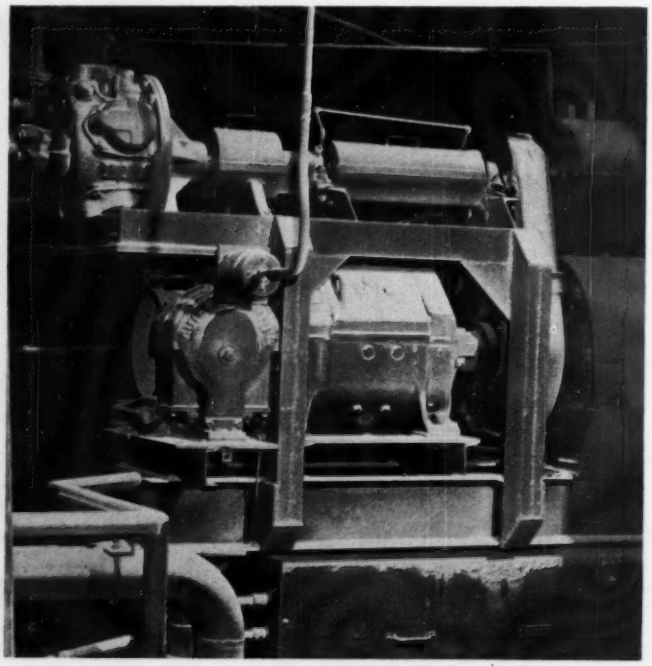


LADLE HEATER One aspect of maintenance is to prevent damage to equipment. The little Ingersoll-Rand BU utility hoist shown here does just that. Prior to tapping a heat from one of the furnaces, ladles are heated to prevent high thermal shock from destroying the ladle lining. The heaters are normally lance-type arrangements and are dropped into the ladle some time before pouring where they stay until the ladle is required. When hand winches were used to lift the ladle heaters, the natural inclination of the man operating the winch was to lift the heater only as high as necessary to clear the ladle. In the rush of tapping, sometimes the heater didn't get clear of the ladle and was struck as the ladle was removed. The addition of the air hoist made it easy for workers to raise the heater completely and avoid damage to it. In the picture, the hoist is at lower left (arrow), the still-flaming heater in the upper left with the ladle filling the foreground at right. The picture below shows installation details of the hoist.





NONMAINTENANCE USES Pneumatic tools are called on by the Kaiser mill for a variety of duties not related to maintenance. Most of these are the familiar chipping hammer and sand rammer applications. Two that are a little unusual are pictured here. Above, a Size 33SM Ingersoll-Rand air drill is used to remove a clay plug from the cast hole in one of the blast furnaces. The pneumatic drill is unaffected by the heat and grit associated with such operations. In the picture at left, a Size 16 Scaler is used on the hammer test in the continuous weld pipe mill. An acceptable piece of pipe will "ring true" when tapped by the hammer, a defective one sounds "dead." The scaler here is pictured removed from its usual support which is out of sight at the end of the air hose shown.



EMERGENCY POWER The lances that inject oxygen into the basic oxygen furnaces are heavy water-cooled shafts that are run right into the furnace by electric-motor-driven hoists. Suspended a few feet above the molten steel bath, the lance delivers a jet of oxygen that impinges directly on the surface of the heat. The risk of a simultaneous loss of circulating water pressure and power for the electric hoists is remote, but Kaiser engineers preferred to take no chances. Such a condition might cause the melting of the lance itself, and the release of its contained water into the steel with an almost explosive conversion of the water to steam. The lances (each 46$^{1}/_{2}$ feet long and 6 inches in diameter) are far too heavy to be raised quickly by hand winches, thus air motors were installed to back up each of the electric drives. Shown in this picture is one of the drives with the electric motor below, the air motor on top. The air motor is an I-R Size KK5M delivering 18-hp when supplied with air at 90-psig pressure.

this & that

Man-Made Lakes In The West

A folder entitled "Reclamation's Recreational Opportunities" lists in a table the 158 storage reservoirs built by the U. S. Bureau of Reclamation in the seventeen Western States and the recreational facilities available. The man-made lakes vary in size from several with 1 mile of shoreline to the Colorado River's huge Powell Lake (1700 miles of shoreline) which will be formed by Glen Canyon Dam, now under construction. Hunting and fishing areas at the reservoirs are listed. The folder gives the town or city nearest each reservoir and the name and address of the agency which can furnish additional information about facilities there. Public accommodations at some are well developed and include lodging, potable water, picnic areas, boat launching facilities and rental boats. According to the folder, some 20 million water-sports enthusiasts, fishermen, hunters and tourists throng the lakes each year. Copies of the publication may be obtained from any Bureau field office or from the Commissioner of Reclamation, Wash. 25, D. C.

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Divers Bring In Oil Well

Richfield Oil Corporation completed an oil well in March that marks another first in California waters. It was drilled from a barge, but was brought in with the help of deep-sea divers who made the final connections. Heretofore, wells have been completed from platforms, islands or holes slant-drilled from shore. The Richfield well, in 55 feet of water, is on a 1175-acre State lease off Rincon point between Ventura and Santa Barbara. Oil from the well flows to Richfield's island some 3000 feet away through a submerged 2-inch steel pipe.

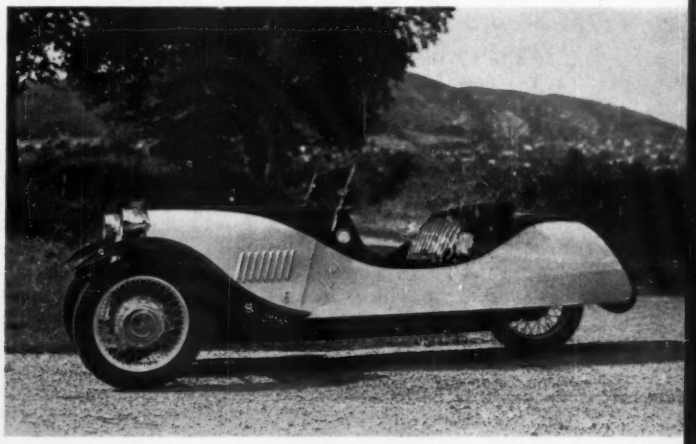
MAN'S OLDEST COMPRESSORS

THE sporting type shown in the left picture here is proving that man's first air compressors, the human lungs, are still very important machines. He is inflating a seat cushion of his Morgan Plus 4 roadster. The Morgan Motor Company is a 51-year-old English sports car manufacturing concern that believes the simple answer to a problem is often the best. The company knows that the tight, road-hugging suspension on its cars doesn't provide the most comfortable ride in autodom. It also knows that different drivers desire different degrees of softness or firmness in their seat cushions. By providing a leather seat with an internal rubber bladder, the auto builder allows each driver to inflate his seat to the desired pressure. The bladder is actually a modified motorcycle inner tube. When air is needed, the driver pulls a stopper and simply puffs away until the seat suits him. Then he places the seat back in the car, fires her up and motors away, literally "riding on air."

The first Morgan was built in 1910 by Rev. H. F. S. Morgan of Malvern Link, Worcestershire, who fitted the car with a 7-hp Twin Peugeot engine. This first car was a three-wheeler (one driving wheel at rear) and had a front suspension that is basically unchanged in the 1957 model you see in the photograph. During the years thousands of Morgan three-wheelers came to dot the English countryside and it wasn't until the thirties that four-wheelers went into production. A 1930's vintage three-wheeler is shown in the right picture. The last three-wheeler was made in 1950.

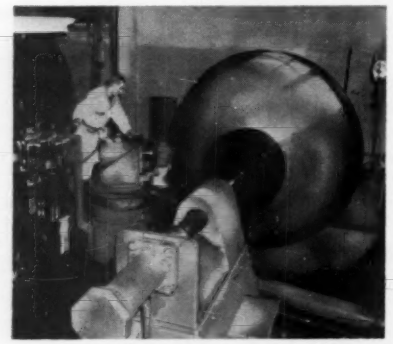
The Morgan company, headed today by Peter H. G. Morgan, son of the founder, has a heritage of racing competition. The three-wheelers were favorites in hillclimbs and field trials (occasionally a fourth wheel would be mounted alongside the lone drive wheel for extra traction). In 1925 a Morgan, with a speed of 104.68 mph for the flying kilometer, set a world's record for the fastest supercharged car. Morgans are popular today for racing in sports car competition in Britain, the U. S. and other countries. The current Plus 4 model, similar to the one shown here, uses a 100-hp Triumph engine and is fleet partially because of its lightness—portions of the body framework are handhewn ash, for example. The car can be supplied with aluminum body, a special highly tuned engine and disc brakes on all four wheels.

Morgans have been around a long time but never have been produced in huge quantities at any one time. Last year, on the event of the company's fiftieth anniversary, Peter Morgan announced that production was at an all-time high of nine cars per week. Lungs for inflating seat cushions, however, still must be provided by the owner.



Goliath Spinning Unit

This unit is described as the largest and most powerful Mecatorn Spinning machine ever developed. Built by the C. W. Torngren Company, Inc., 236 Pearl Street, Somerville 45, Mass., the hydraulically operated device is capable of spinning stainless steel and other high tensile steels to 1 inch in thickness and 10 feet



in diameter. It will spin the metal hot or cold and utilizes a heating system supplied by a mixture of liquid propane gas and oxygen. Intricate configurations such as reactor seal membranes and reentrant curves, common on venturi thrust chambers, are said to be its specialty. Temperatures are controlled by the use of Tempil sticks or optical pyrometers. Upwards of 300,000 psi force is exerted by the rolling tool. The tremendous pressures, combined with the unique heating system, will enable its manufacturer to experiment on the "rarer" refractory metals. No unit before has attempted such spinning, says Torngren, because extreme pressures and high temperatures are required. The powerful process is said to save money as a substitute for forging. It would eliminate the high cost of dies, extra amounts of material required in forging and the expensive machining to attain final shape. The unit gives refined grain structure and increased tensile strengths, due to the cold forming.

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Turn Left At The First Pink Bump

Highway bumps are at their worst when they can't be seen but a new reflective paint may help expose them. Tests will be run in New York State this summer on a paint that is applied to the forward sides of the slightest road bumps. Preliminary tests show that the paint provides a clearly defined lane for night motorists, whereas the opposing lane appears dark. An object in the bright lane is seen from a greater distance and the paint raises the over-all level of illumination achieved by car headlights. To put on the material, a special applicator was built that allowed a truck to move at 30 mph as it sprayed on a 5-foot-wide strip. The paint was blown in a fine mist at an airspeed of 70 mph and just touched the sides of the bumps facing the truck. New York's State Bureau of Physical Research spent $30,000 in the preliminary trials and now plans to give the method a chance on ordinary highways. A red shade of the paint eventually might be used at dangerous intersections and yellow could be used in caution areas. Pastels might break up the monotony of all-night driving.

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Memories Of The War

Captive balloons were seen recently flying over an empty lot in London, England—balloons similar to the barrage type used during the Battle of Britain. Their use was not to prevent destruction, but to aid construction. A 36-story office building is being contemplated for the area and the blimps were used in its planning. They rose some 400 feet and were anchored. Then photographs were taken from various vantages so that some idea could be gained of what the new London skyline would look like. We doubt that such an application will result in a major rise in production for the lighter-than-air craft manufacturers, but we do agree that such an operation could help eliminate some of the urban monsters on today's drawing boards.

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St. Lawrence Ice Control Study

A preliminary study has shown that it is feasible to keep the entire St. Lawrence Waterway navigable all year round. Right now, ice jams block ships from going any farther than Quebec City for 4 months of the year; it is not until about late March that the first vessel plies through to Montreal. Canadian government icebreakers keep a channel of sorts clear but this is primarily to prevent the build-up of flood waters, not as a shipping aid. The 192-mile stretch from Montreal to the Seaway proper is icebound from mid-December to mid-April.

Several different techniques would be needed to solve the problems of ice at various sectors in the river. The greatest difficulty is ice jams. These form when surface ice breaks free in the quiet river areas and in lakes where there is little current. Floating downstream, the ice collects in basins. The floes are cemented together by "frazil" ice—crystalline particles that form in turbulent water. Once a jam starts, it grows rapidly. Jams near Montreal have reached 90-foot depths.

Jams can be prevented by removing surface ice from the navigation channel and by preventing the formation of frazil. Floating booms and rock barrages might keep ice out of the channel; the barrages would also control the flow of the river. Where frazil is the most serious problem, as in the area between Montreal and Quebec, two full-sized dams are proposed. Both could be used for hydroelectric power generation.

Where the river current is too slow to prevent surface ice from gathering—as in quiet harbors—bubbler systems are proposed. One installation of burper guns was tested last winter in the Seaway on a development basis. Burper or bubbler systems bring the warmer lower water to the surface (see "Battling with a Bubble Gun," *Compressed Air Magazine*, January 1961). Two systems, each 16 miles long, would be needed to define and protect the navigational channel through Lake St. Peter, below Montreal. A similar arrangement has been used in Lake Malaren in Sweden—a $4^1/_2$-mile system keeps the lake free from ice where it normally would form a 20-inch layer. In an alternative system tried recently in the Antarctic, submerged propellers might circulate water below the ice and gradually wear it away.

The St. Lawrence Seaway locks would be a special problem. One proposal is that thermal power-generating stations be built near the locks and the condenser cooling water be used to keep the locks ice free.

Long stretches of the St. Lawrence would need little additional work in preventing ice. The icebreakers and the warm westerly Laurentian current now keep the Quebec north shore ports and the southern Newfoundland ports open to winter navigation.

The over-all system for ice control in the St. Lawrence is based upon sound engineering principles, but would be expensive. However, it is estimated that if the river were navigable the year round, business in the inland ports could improve 50 percent—more than enough to warrent the high cost. A report of the feasibility study was given recently in "Industrial Bulletin," an Arthur D. Little, Inc., publication.

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Echos With A French Accent

In France the Ministry of the Post, Telephone and Telegraph, (PTT) has set up an experimental space-age post office in tiny (770 inhabitants) Nancay. Each night French engineers from the Centre Nationale d'Etudes des Telecommunications receive messages from Bell Telephone Laboratories scientists in the U. S. The signals are bounced off Echo I as the satellite orbits over France. PTT authorities forsee that the experimental echos from Echo may provide data for designing a communications system.

editorials

Steel Tales

STEEL production is up. The nation's press heralds the news in a fashion not completely typical of ordinary business information. Rightly so, say economists, for generally speaking as steel goes, so goes the rest of industry. The consensus is that the just-past downturn may well have ended with the 20-year steel-output low in December. Ingot tonnage has risen every month since.

We have been privileged the last few months to visit a variety of steel plants throughout the country. Some were completely integrated facilities. Others did little but cast and forge. Some specialized in certain types of special-duty steels, including those for missiles and space flight duty. We've about run the gamut of the iron and steel industry in these travels, obtaining material for articles that have appeared or that will in future issues. This month for example one of our editors has covered the tub-like blowing machines used at an early iron making establishment. The site, recently restored, is part of the heritage of the industry. In another article we cover the important maintenance tasks performed by air powered tools in a modern steel plant.

During the past few months we have reported the role played by compressed air in the casting of steel products for heavy industry, and for space-age applications; a variety of special pneumatic powered equipment for steel mills; and a number of methods of finishing, handling or fabricating steel that rely on air power. We also covered the compressed air and rock drill applications in the opening of a vast new iron ore field.

In months to come we shall have material on air powered forging of steels; on vacuum degassing and melting; on automatic compressed air systems for mills; and on air fractionating plants making oxygen and other gases for steel mill usage.

The wide variety of these articles is indicative of the importance of compressed air technology to steel. An undercurrent of purpose runs through many of the operations described—almost without exception a search for time and labor saving equipment and methods led to the selection of pneumatic equipment and methods. Ofttimes these can be applied in other industries with the same time, labor and money savings.

SCUBA Standards

A RELEASE by the American Standards Association reveals that nineteen user, manufacturer and safety groups are attempting to establish a sectional committee of the Association to study standards for scuba (self-contained underwater breathing apparatus) diving, and also for hookah and skin diving. (Hookah divers receive an air supply from the surface; skin divers do without breathing aids.)

The Saftey Standards Board of the ASA is now considering the proposal. Assuming that a study is authorized, it would delve into safety practices as well as equipment standards. Specific suggestions have been made concerning tanks and tank markings, connections, masks and goggles, flippers, compressors and the quality of breathing air in general. The Compressed Gas Association has tentatively agreed to serve as administrative sponsor of the study.

A conference of the organizations involved indicated that the standardization work is, perhaps, long overdue. The consensus is that the relative absence of serious accidents in the field has been as much good fortune as good practice. Pressures of from 2000 to 3500 psig are commonly encountered, and are certainly not suitable for the inexperienced to play with. Nor can shortcuts be taken in the manufacture of equipment. There are other factors. That air is actually used for breathing, sometimes at pressures of several atmospheres. Any contamination can be dangerous, even toxic under these conditions, even though it might have no physiological effect at normal pressures.

Scuba diving has been called one of the fastest growing participation sports. It has a great deal to offer active persons of all ages. And there is no reason that it cannot be carried on safely and without hazards significantly greater than, say, ordinary swimming or boating. Over the years since its inception, however, the safety of its adherents has rested largely on the individual integrity of the manufacturers of equipment and suppliers of pressurized breathing air. Actually it will continue to do so, but the establishment of a set of standards to work to, and the formulation of safe-practice rules under stringent scientific observation will certainly do much to safeguard the sportsman and enhance the utility of the method to commercial venturers.

HOPEWELL

'Though the Pungent Odor of This Old Iron Furnace

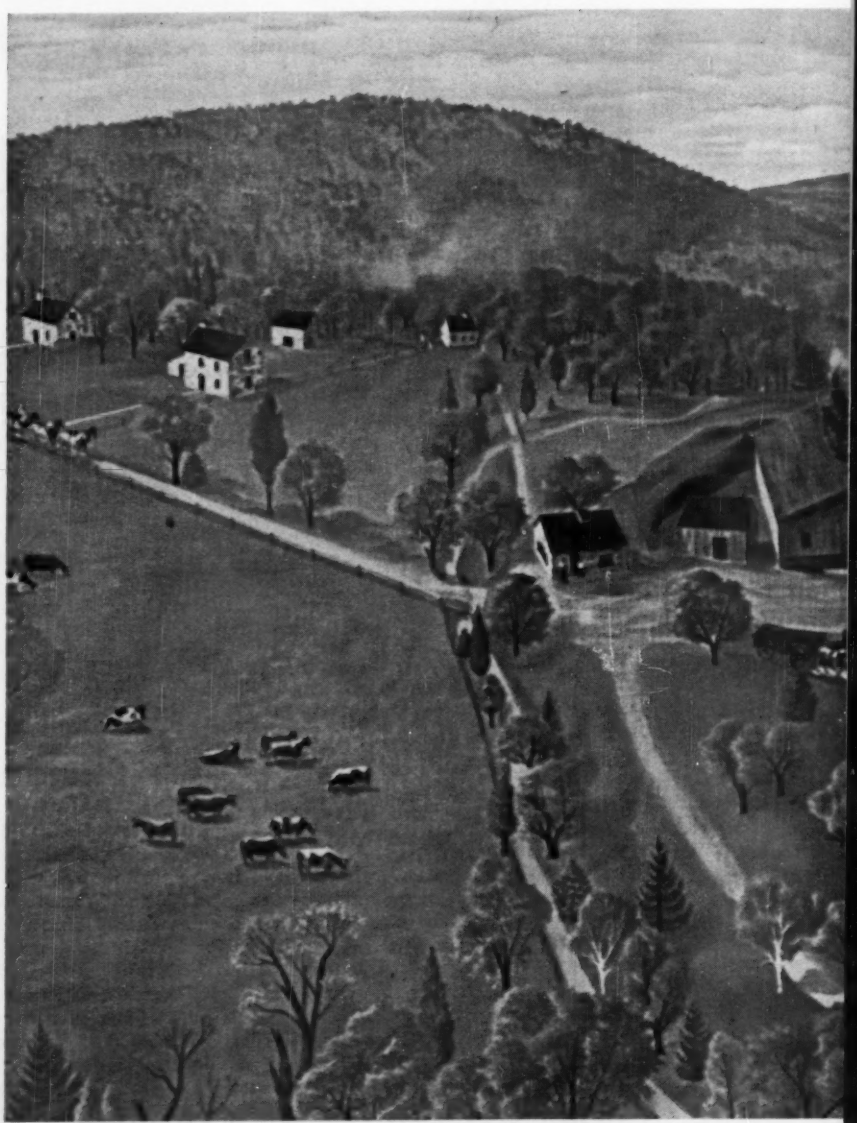
C. H.

AT HOPEWELL Village, secluded in the scenic rolling hills of Berks County, Pa., a colonial blast furnace that used charcoal fuel for smelting iron ore has been restored essentially as it was when it last operated 78 years ago. Some of the associate structures for producing castings as well as facilities for carrying on community life and housing the people and animals concerned have also been restored and work on the others is in progress.

The project is being administered by the National Park Service and Hopewell Furnace was designated a National Historic Site on August 3, 1938. The Federal Government purchased 848 acres, including the furnace site, in 1935 from members of the Brooke family. The sellers were descendants of two Brooke brothers who acquired the ironworking establishment in 1800 and were its most successful operators. Incidentally, the Brookes of today are still active along related lines in the Birdsboro Corporation, which was until 1960 the Birdsboro Foundry & Machine Company. Initial preliminary work of creating a recreational development area was done by the Civilian Conservation Corps (CCC).

Hopewell Village, which is a modern designation applied by the National Park Service, is a few miles southwest of Pottstown and roughly 40 miles northwest of Philadelphia. Good roads make it readily accessible now, but in years gone it was so far off beaten paths that some of the structures were little disturbed and this accounts for their being well enough preserved to make this one of the easiest of colonial ironworks to restore. The National Historic Site is within the larger French Creek State Park, which attracted 750,000 visitors in 1959. About 100,000 of these visited Hopewell Village.

Hopewell Furnace was one of numerous early ironworks established throughout southeastern Pennsylvania in what are now Berks, Bucks, Chester, Montgomery, Lancaster and Cumberland counties. While not one of the first of its kind, it was among the largest and had the creditable performance record of operating almost continuously from 1771 to 1883, a span of well over a century. Like all other colonial iron furnaces, Hopewell was the center of a thriving community or "plantation" whose inhabitants depended upon the ironworks for a livelihood and where the ironmaster was a sort of beneficient overlord.



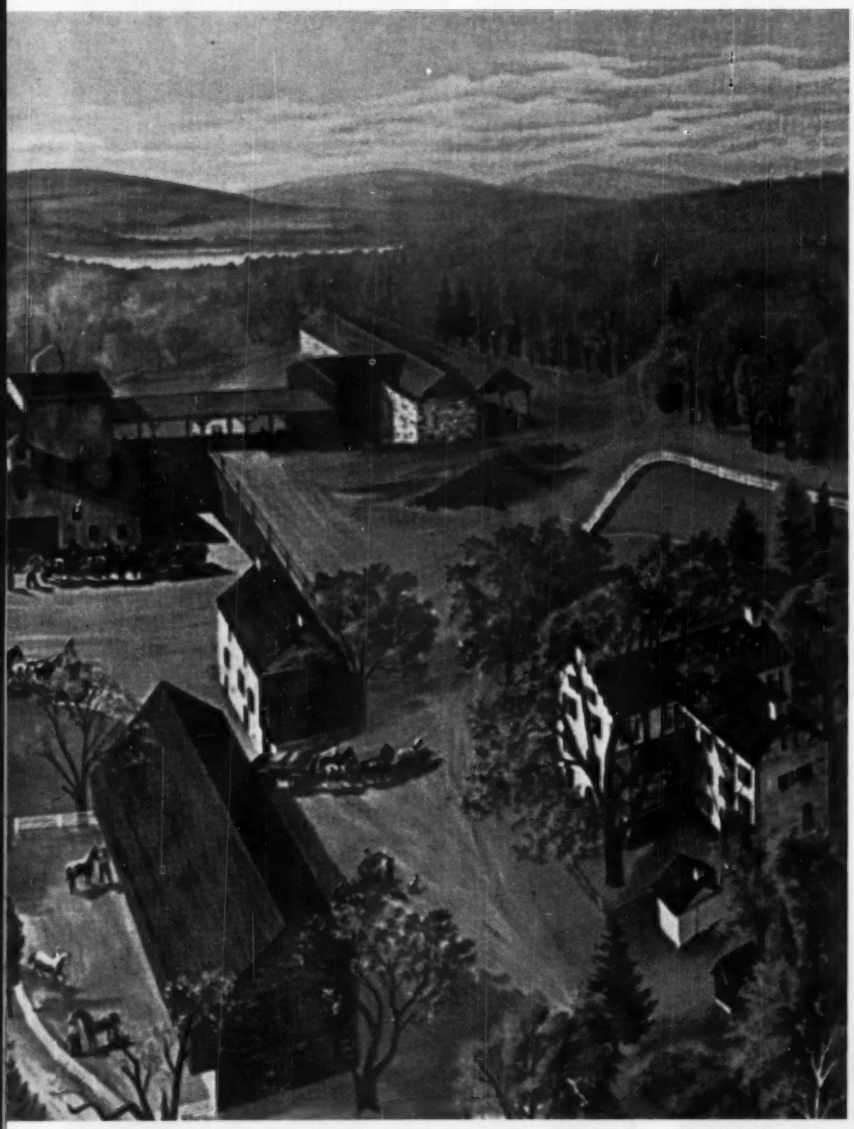
AS IT WAS **Hopewell Community as it probably looked in the 1830's. The furnace and associated structures are at upper center. Smoke is rising from the furnace.**

It was virtually necessary that the early colonists establish ironworks. What few iron articles they got came at first from England. But, with the source so far away and Britain's iron industry declining steadily because of a dwindling supply of wood for making charcoal, the colonists soon looked for domestic iron ore deposits that could be developed. They made an effort as early as 1621 to establish an ironworks at Falling Creek, Va., 66 miles north of Jamestown, but Indians destroyed the structures in the following year and killed John Berkeley, the ironmaster, and 346 other persons. The real start of the industry was made in 1644 at Lynn, Mass., on the Saugus River, by skilled workmen from England, and at nearby Braintree, a few miles south of Boston.

VILLAGE

Charred Hickory Is Forever Gone, Endures as a National Site

VIVIAN



French Creek runs down the left part of the painting and farther to the left are tenant houses. At right are the ironmaster's mansion, a barn and the company store.

Both operations used bog iron ore. The Saugus works was restored in 1956 by the American Iron & Steel Institute. (See *Compressed Air Magazine*, August 1956.)

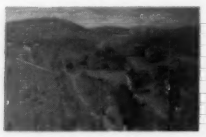
The infant industry spread into Connecticut and Rhode Island and by the end of the century was firmly rooted in New England. It next pushed into New Jersey and Maryland and then into Pennsylvania, where it had its greatest expansion. The Pennsylvania operations began under the influence of William Penn, who had been connected with the manufacture of iron in England. Soon after his arrival here he became interested in iron mines in Sussex County, N. J., and later encouraged the founding of an iron industry in his own province, which abounded in the necessary natural resources: iron ore, timber for making charcoal, and limestone for furnace flux.

Colonial ironworks were principally of two kinds: the blast furnace, where pig iron and castings were made; and the bloomery forge, where wrought iron was produced directly from ore or from pig iron. In either case the malleable metal that resulted was suitable for making nails, implements and tools.

Pennsylvania's first successful iron operation was a bloomery forge set up on Manatwany Creek in Berks County in 1716 by Thomas Rutter, a blacksmith. Then came Coventry Forge on French Creek in Chester County, built by Samuel Nutt about 1717. The iron worked there was called the equal of the best from Sweden. About 1720, Colebrookdale Furnace on Ironstone Creek was built by a company in which Rutter was interested. It was 8 miles west of Boyertown and supplied several forges with iron. In 1731 it was being operated by a company that included Thomas Potts, for whom Pottstown was named. He was at one time Pennsylvania's most successful ironworker.

By 1770, when Mark Bird built Hopewell Furnace, sixteen other furnaces in the province were already producing around 6000 tons of iron annually. There were 2,250,000 colonists and Philadelphia was the second largest city in the British Empire. Mark Bird's father, William, learned ironworking under Thomas Rutter at Pine Forge. With money saved, he acquired extensive woodlands west of the Schuylkill River and built New Pine Forge in 1744. He also started construction of a forge on Hay Creek, where Birdsboro now stands. In 1755 he built Roxborough (Berkshire) Furnace. Later he took up more land and at his death, in 1761, had holdings valued at 13,000 pounds sterling. His residence in Birdsboro (the city was named for him) is now the local Y.M.C.A. headquarters.

Mark Bird took over these properties when his father died. Nine years later, on French Creek, a tributary of the Schuylkill River, he built Hopewell Furnace. The date 1770-71 is cut into a block of stone in the base of the furnace stack. The furnace was a truncated pyramid of native stone standing at the foot of a hill near the creek, from which a flume conveyed water to a large wooden wheel that operated the blast machinery. Spanning the opening between the furnace and the adjacent hill-



side was a "bridge house" through which the "fillers" carried ore, limestone and charcoal, which they dumped into the top of the furnace stack. These materials of the "charge" all came from nearby. Normally, 2 tons of ore, between 180 and 200 bushels of charcoal and about 25 shovels of limestone made a ton of iron.

The Pennsylvania ore was largely magnetite and little or none of it was "bog ore" such as some of the furnaces in New England and New Jersey used. The ore for Hopewell Furnace came from four sources, all within 4 to 6 miles. Warwick Mine, which was probably drawn upon intermittently from 1771 until the furnace closed, also supplied ore as far away as Windsor, Joanna, Mt. Penn, Warwick and other furnaces. Jones Mine contributed ore to Hopewell from Revolutionary War times until 1883. St. Peter's, or French Creek, Mine was a minor source in the 1840's and 1870's. All three of these mines produced magnetite. Another late and minor source of supply, Garman's Mine on Welch Mountain, yielded hematite.

The ore was found at or near the surface and sufficiently broken up to require little drilling and blasting. At least, Hopewell records contain no entries for purchases of powder in quantity. There was, however, some underground mining. Shaft sinking began at Jones Mine around 1820 and later at Warwick.

The mine sites mentioned are within 6 or 7 miles of Bethlehem Steel Company's new Grace Mine at Morgantown, which is producing magnetite from a deposit that is buried more than a quarter-mile beneath the surface. It was located in the autumn of 1948 by trailing a magnetometer from an airplane. Evidence of the ore body was verified by putting down about 25 diamond drill holes. The cores revealed the presence of ore of about 40-percent iron content extending from a depth of 1524 feet to at least 3000 feet. Bethlehem is now mining the deposit through two shafts, one 2208 feet deep and the other 3079 feet. At full capacity, it will produce about 12,000 tons of ore daily and employ around 1150 men. The ore is crushed, its iron content extracted magnetically and then made into pellets having sufficient strength for blast furnace use. The pellets are shipped to Bethlehem's large steel plant at Bethlehem, Pa.

In addition to opening the Grace Mine, Bethlehem has purchased 510 acres of land about 2 miles south of Hopewell Village and just north of the old Warwick Mine. Presumably there is more buried ore there, although no public announcement concerning it has been made.

Charcoal was prepared in the forests and this required considerably more men than the mining of the ore. Hickory was considered best for the purpose, but was somewhat scarce and the more abundant black oak and chestnut were most used. Some furnaces used daily the 20- to 25-year-old trees from an acre of woodland. The main drawback of charcoal fuel was its ease of crushing. Chiefly because of this, colonial furnaces were rarely more than 35 feet high. Hopewell Furnace was probably 30 feet high, 27 to 28 feet on each of its four sides at the base and 7 feet across the widest part of the interior, termed the bosh.

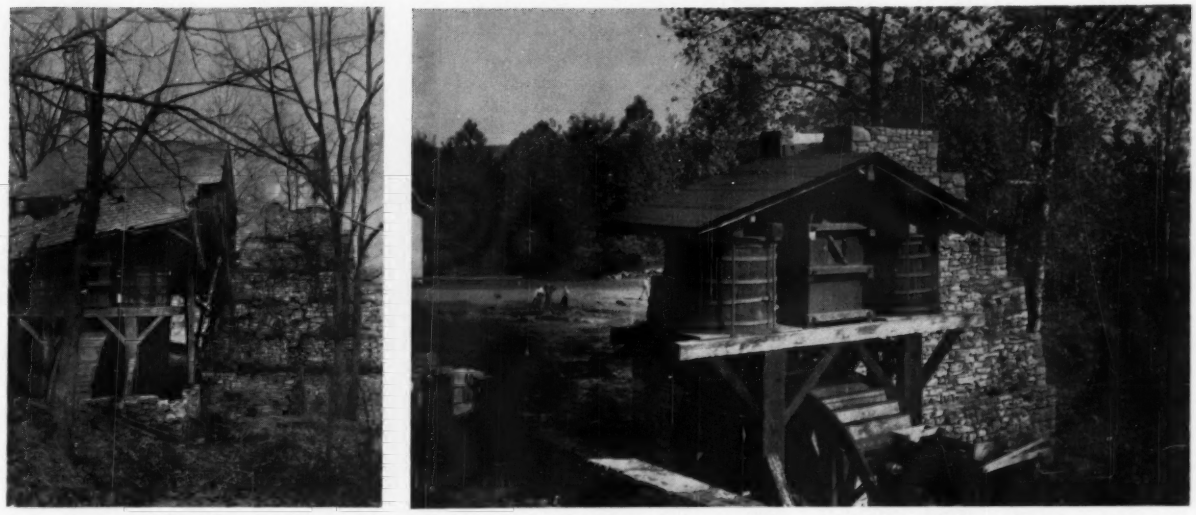
Limestone, like ore, was obtained from shallow workings. All of the raw materials were hauled to the furnace site in horse-drawn wagons and stored on the furnace bank. Because charcoal deteriorated when exposed to the weather, it was put under roof in a structure at the hillside end of the bridge.

At Hopewell one may see a good example of a pioneer air compressor or blowing apparatus—forerunner of the modern blast furnace blower. Like all colonial furnaces, Hopewell first used bellows to produce the blast of air needed to intensify the charcoal fire that smelted the ore. To provide a continuous flow of air, two bellows were operated alternately by a 30-foot overshot water wheel. The bellows were closed when contacted on top by studs or cams on the revolving wheel and then opened by counterweighted beams.

A reciprocating blowing unit like the one included in the restoration replaced the bellows about 1800, it is believed. The change was made, it is thought, when Hopewell Lake was built to increase the volume of water through storage. This is said to have been necessitated when one of the two headraces was lost in a law suit. The time was 250 years after the blowing engine, as it was known, had been invented by Hans Lobsinger, an organ builder of Nuremberg, Germany. Steam drive for these engines was adopted in many British ironworks within a short time, but most colonial furnaces continued to utilize the slow-turning water wheels that had previously worked their bellows.

The blast equipment at Hopewell has been rehabilitated essentially as it was in 1883. Details were taken from the existing 1883 apparatus and from drawings made by Franklin Institute in Philadelphia. It is built almost entirely of wood, as was the custom. The water wheel is 22 feet in diameter and 5 feet across the face. Cranks and connecting rods at each side of the wheel give a reciprocating movement to a piston in each of the two cylinders or "tubs" overhead. The latter are made of staves like a barrel, and held together with iron straps passing around them. Each tub is approximately $6\frac{1}{2}$ feet in diameter outside, 6 feet inside, and 4 feet 10 inches high. Between the tubs is a windbox

CONTRAST The furnace as it looked in 1887—4 years after the last blast—and as restored. The furnace is at left. Ore, charcoal and limestone were carried through the overhead "bridge house." A wall at lower right divides upper and lower levels.



BLAST MACHINERY About 1800, blowing "tubs" replaced bellows that originally supplied combustion air to the furnace's charcoal fire. The crude compressors are shown at left as they appeared in 1838, and, at right, as restored in 1950 before being housed. Pistons, driven by the water wheel below, reciprocated within the wood-stave cylinders.

into which the compressed air was directed and which served to insure a continuous supply. According to the American Iron & Steel Institute, an 1855 report stated that the Hopewell wheel made one and three quarters revolutions per minute and delivered air to the furnace at $^3/_4$ psig pressure through a "tue-iron" (now tuyere) that entered the furnace at an archway near the bottom.

An inventory of Mark Bird's properties, taken for taxation purposes in 1779, listed 10,883 acres of land, 1 furnace, 2 forges and a two-thirds interest in Spring Forge, 1 slitting mill, 1 saw mill, 2 pleasure carriages, 28 horses, 30 working oxen, 18 horned cattle, 12 Negroes, 1 servant and 3767 pounds sterling in cash. In 1772 Bird had been the highest taxpayer in Berks County and one of its wealthiest citizens.

The furnace had a capacity of 700 tons of iron a year before 1789, making it second only to Warwick Furnace, which was rated at 1200 tons. Pig iron was the leading product, followed by pots and kettles, stoves, hammers, and anvils and also castings for making forgings.

The molten iron was run out of the furnace into "sow-and-pig" patterns in the sand on the floor. The other products were formed in the casting house adjoining the furnace, using molds made by pressing wooden patterns into sand. Castings made in this way were thick and heavy and expensive to transport. A wagon load was limited to about 2 tons and a day's trip to about 12 miles. Although some products were delivered as far as Philadelphia, this was unusual and most customers were within 15 miles of the furnace.

The crude casting technique, poor transportation facilities and scarcity of customers limited production for 50 years. The opening of the Schuylkill Canal in late 1824 and the development of flask molds for casting made conditions better. Meanwhile Bird used some of the iron in his forges in the Birdsboro area, working it under hammers powered by water wheels to remove excess carbon and make the metal malleable. Some of the hammers for forging were cast at Hopewell. One on display weighs 585 pounds.

It is estimated that around 100 workers, including probably 40 part-time woodchoppers and colliers from the surrounding countryside, ran the Hopewell establishment during this period. Village residents were both free and indentured, a daybook of 1784 showing five in the latter class—two English and three Irish. Negroes were employed, mostly as carters, but there is no indication that they were slaves. The twelve listed on the 1779 inventory probably worked at one of Bird's forges. One, named Cuff, was a skilled hammerman.

Mark Bird's patriotism contributed to his financial undoing. As a lieutenant-colonel of Berks County Militia during the Revolutionary War, he outfitted 300 of his men with uniforms, tents and provisions. The products of his ironworks were largely turned over to the government and, in February 1777, he sent 1000 barrels of flour to Washington at Valley Forge. Orders aggregating several hundred thousand dollars were issued to him but he apparently collected little or nothing on them. On September 15, 1783, he requested the Continental Congress to give him, as part payment, the Great Chain that had been stretched across the Hudson River at West Point to block British navigation. His plea was denied on the ground that this would be showing favoritism to one of numerous creditors. A flood, debasement of the currency and a general post-war depression eventually ruined Bird. When he defaulted on a loan of 200,000 Spanish silver dollars he had received from John Nixon, a Philadelphia merchant, his properties were seized and sold by the sheriff and he moved to North Carolina, where he died in comparative poverty.

Hopewell Furnace then passed through several hands. From 1793 to 1800 it was operated by James Old & Company. Old was the father-in-law of Robert Coleman, the ironmaster at Cornwall Furnace, one of the province's largest and finest. The profits didn't meet the payments on the mortgage of 8857 pounds sterling Old had given and title reverted to the mortgagee, Benjamin Morris. The latter sold the property in August 1800 to a partnership made up of Matthew and Thomas Brooke, brothers, and their brother-in-law, Daniel Buckley. Under this ownership, Hopewell had its greatest prosperity.

Its best years were 1829–39 under the direction of Thomas Brooke's son Clement, who, in 1816, began a run of 33 years as the ironmaster. He expanded the flask casting of stove iron and between 1831 and 1842 two-thirds of the furnace's production went into stove plates. Cooking stoves had recently been improved, casting technique had advanced and the canal was open. The bulk of Hopewell's stove plates went to Philadelphia, New York and New England. Most of them were made from patterns sent by the city stove merchants. The plates were shipped to these customers, who assembled them by adding the hinges, bolts and miscellaneous hardware required.

Until then, most cooking had been done at fireplaces, which were also the only sources of heat. Stoves required

less fuel, heated rooms more evenly, were cleaner and more convenient and didn't heat up a house when used for summertime cooking. At one time Hopewell produced up to 60 types and sizes of stoves. In 1841 and perhaps a few other single years, about 5000 units were sold.

Prices of castings fluctuated widely from year to year. In 1836 the demand exceeded the supply and Hopewell profits are said to have reached $40,000. A letter from a customer named William Cunningham to Clement Brooke & Company, dated March 8, 1842, shows that stove castings were then selling for $62.50 a ton. There were no central markets to determine prices, which were arrived at mainly by negotiations between buyer and seller. Everybody bought on credit and it was hard to check a prospective customer's financial rating or reputation.

Many records of Hopewell's operations have been preserved, especially for the period when the Brookes were in charge. Married workers lived in tenant houses, apparently rent free. By that time, these structures, probably originally of logs, had been rebuilt more substantially and several of them have survived in a fair state of repair. The average family kept a cow, grew vegetables and received free wood for household fuel.

The ironmaster occupied the mansion or "Big House" which overlooked the sites of the principal operations. The structure originally consisted only of what is now the north wing, but was enlarged as the venture prospered. Clement Brooke lived well there and entertained lavishly, as was the custom for those in his position. He personally managed every phase of the operations, received a salary of $600 a year and also a share of the profits.

Mrs. Brooke managed the mansion. Visitors ate there and when extra workers were employed they were fed in the basement, where food was cooked at an open fireplace. Mrs. Brooke received $69.33 a year. A helper, Polly Parliment, got $1 a week, plus room and board, for cooking, baking and doing the housework. Back of the mansion was a garden, attended by a man who received $14 a month.

If incomes were low, so also were expenses. For example, in the early 1880's, beef by the quarter was 22 pounds for $1, about 15 pounds when cut up. There was, of course, no mechanical refrigeration but perishables kept well in a stone springhouse near the mansion, where such things as milk, cream and butter were stored in large crocks.

Thomas Foster, the company clerk, was paid $300 a year for keeping the records. In the blacksmith shop, machinery was made or repaired. Also metal equipment for the ironworks, and hardware and implements for the villagers were turned out and horses shod. A hostler cared for the animals.

The store handled all ordinary things needed by the workers, including food, clothing and furniture. Occasionally, upon request, something special was brought back from Philadelphia by the man who delivered Hopewell's products there. Although this was a cash economy, little cash changed hands. Earnings of employees were entered in a ledger and store purchases in another book, from which they were transferred to the ledger about four times a year. Some furnace workers were credited with wages about four times a year, or after each blast. Other workers were credited more often, but it appears that the books were not balanced each time.

About 50 account books and 5000 documents and letters relating to transactions have been collected. They show that, in effect, the company served as banker for its employees. For them, through the credit system, it paid the doctor, visiting tailor and shoemaker and even church pew rent, the gravedigger and coffinmaker. All the evidence points to a rather easygoing relationship. If a family overspent its income, an adjustment was made later.

Neighboring farmers sold to the company their surplus hay, grain, cord wood, cattle and hogs and their own and their sons' labor. In return, they often bought from the company store and had work done at the blacksmith shop.

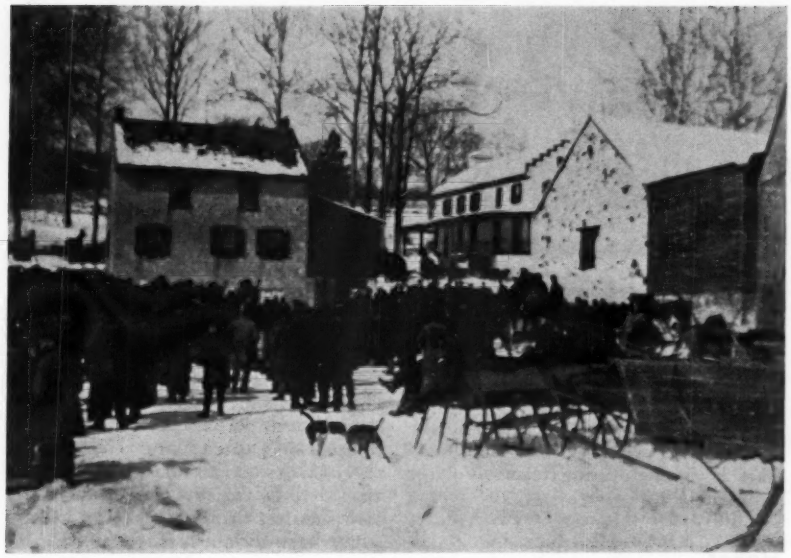
Under Brooke management, four blasts that produced more than 1000 tons of iron each were made. The longest run, from January 3, 1836, until April 10, 1837, yielded 1178 tons. The record high production of 1205 tons was made during the blast of 1853. The third highest blast, in 1857, produced 1094 tons.

About 65 men were on the regular payroll at the time of the longest blast. In addition, around 40 part-time woodchoppers received from 27 to 30 cents a cord. Normally, a furnace was operated about 9 or 10 months a year, closing down usually in the spring. Necessary repairs were made then and surplus hands went into the forest to cut wood. Three colliers, each with a crew, received about 30 cents a cord for making the charcoal.

Two "fillers" charged the furnace and the "gutterman" tapped the furnace and directed the molten iron into the sow-and-pig molds. Up to to sixteen molders turned the cast iron pigs into useful products. During the longest blast, they made 720 tons of castings.

The decline of cold-blast charcoal furnaces began when the hot blast was introduced (at Oxford Furnace in New Jersey in 1834) and the use of coal as fuel began. At the peak of charcoal production, 212 Pennsylvania charcoal furnaces turned out 98,395 tons of iron a year. One hundred forty-three charcoal furnaces produced 96,154 tons of iron in 1856, while only 95 hot-blast furnaces using anthracite coal accounted for 306,712 tons and 27 furnaces using coke or raw bituminous coal produced

THE BIG HOUSE A front view of the restored mansion where the ironmaster lived. Originally of modest size, it was enlarged as the ironmaking venture prospered.



WINTER SCENE This picture, taken in the early 1890's, shows that there was then still plenty of activity at Hopewell Furnace.

47,370 tons. Twenty years later, only 27 charcoal furnaces survived and their annual output was 23,099 tons.

Production costs rose at Hopewell as the richer ores were depleted. In 1852 a ton of iron could be made from 1.94 tons of ore and 146 bushels of charcoal. By 1872, the requirements were 2.42 tons of the leaner ore still left and 184 bushels of charcoal. Anthracite iron had become less expensive to make than charcoal iron; also, the day of the cold-blast furnace was over.

Along with these changes, Hopewell's stove plate business suffered from depressed and changing economic conditions. In 1841, many merchants couldn't pay for the plates they purchased. About that time, also, foundries located in the cities took over most of the stove plate business. They could control quality better than the backwoods furnace, and were soon turning out a better product. Hopewell then began selling some of its iron to foundries and forges. After the Civil War, a lot of it ended up in wheels for railroad cars. From 1870 to 1883, A. Whitney & Sons, a large car-wheel manufacturer in Philadelphia, took most of the output.

Hopewell tried in many ways to keep going in the face of adversity. In 1853 a blast furnace that used anthracite coal was put in but closed within a few years. Possible causes were inability to obtain suitable ore and the heavy expense of freighting in the coal. The charcoal furnace continued to operate but was losing out. The best ore was gone and that which remained was so high in sulphur and other impurities it caused metallurgical troubles. Also, the yield of iron per ton of ore was declining.

In a final effort to improve efficiency, a steam boiler fired by waste gases from the furnace was set up to provide auxiliary power for the water wheel; and an ore roaster was added in 1880 to calcine the ore. For some reason, steam was used only briefly and then because a drought reduced the supply of water for the wheel. During the same period, the water wheel was rebuilt and the blast equipment modernized. However, these steps were in vain. In 1883 Hopewell finally closed.

Hopewell is the second Pennsylvania colonial furnace to be restored. Cornwall Furnace, which also closed in 1883 after operating 141 years, was rebuilt in the early 1930's through the generosity of Mrs. Margaret Buckingham, whose forebearers ran it as early as 1786. It was presented to the state, which maintains it as a museum.

The work remaining to be done at Hopewell includes restoring the cast house, reconstructing three buildings completely, and rehabilitating unfinished portions of the mansion and some of the tenant houses. The improvement program, designated by the National Park Service as Mission 66, is scheduled for completion in 1966.

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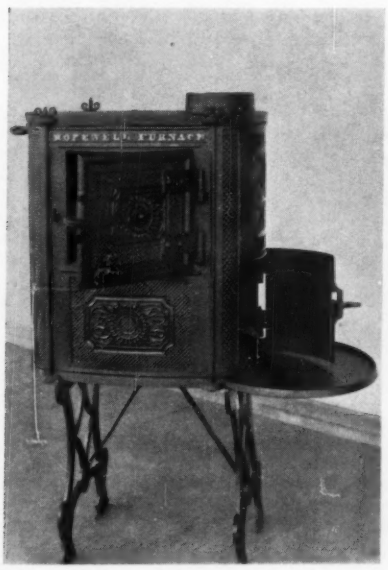
WASHING ORE Iron ore occurred at or near the surface. Before being hauled to the furnace, the ore's impurities were washed out in a sluiceway. At left is a 9-plate stove produced from such metal. It was made by the flask molding process, an improvement on the wood-carving-pressed-to-sand-mold method used earlier.



PERIODIC PREVENTIVE MAINTENANCE

Air Hoses, Clamps and Couplings

THE REAL goals of a planned preventive maintenance program are to increase efficiency and cut costs. This statement, which has been the underlying theme of the present series of maintenance articles, is applicable to all parts of every pneumatic system.

Consider air accessories—hoses, couplings, in-line air valves, air cylinders and the like. They are installed in the initial air system, but then are often overlooked. Yet, they must be considered if an air system is to function effectively, efficiently and at the lowest possible cost.

As pointed out, a well-regulated preventive maintenance program saves pneumatic tool replacement costs as well as air-use dollars. The same is true if applied to industrial hoses, clamps and couplings. These air system components are constructed to function properly with rough treatment. However they must not be needlessly maltreated. As for air dollars, remember that for every 10-psig-pressure drop at a pneumatic tool, output (which can be measured in dollars) is decreased by 18.5 percent. It follows that maintenance of rubber hose, and its associated clamps and couplings, to prevent air leakage will yield major dividends. And as with maintenance of pneumatic tools, an organized program is as important to the garage owner with his small air system as it is to engineering teams in large industries.

DESTRUCTION The hose in this picture will not have a long service life if such bending to shut off the air supply is practiced regularly. Shut-off valves should be used instead.

Hoses

Think of a compressor as a body. Pneumatic tools are the hands. Hoses then become the arms of an air system. Hoses give tools flexibility, get them into remote areas, permit them to operate far from compressor installations. Unfortunately, hose is taken for granted, and consequently mistreated through negligence. Emphasis placed on the body and hands of an air system must be shared with hose and its complementary accessories. What is required here is not so much a periodic maintenance program as a constant awareness of possible unsafe and wasteful practices.

Maintaining industrial hose starts with the arrival of the first shipment. Receiving department personnel should be warned to use hooks, knives, sharp tools and other aids to uncrating with care. A misguided movement might puncture hose, spoiling it before it is even installed.

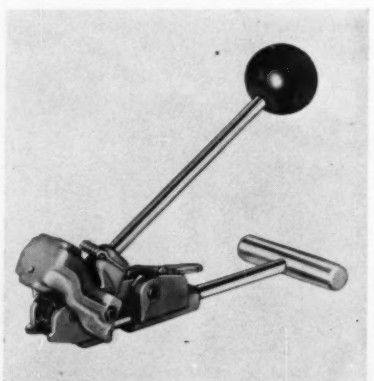
Rubber hose should be stored in cool, dry areas. Sunlight, acid fumes and oil can be harmful. Ozone, even in minute quantities, quickly oxidizes rubber. Hoses of this material should not, therefore, be kept in closed rooms that house generators or electric motors. Ruinous premature aging results.

In storage and after use, hose can be hung on wooden pegs. Reels and racks are even better. Hanging hose on sharp nails or projections from equipment, using boxes or bins that are too small and cramp the lines, dropping hose in a heap on the floor—all shorten valuable service life. In some factories hose is coiled on shelves, which is also good practice. Air can circulate around it preventing mildew to fabric covers. And the hose is out of the way.

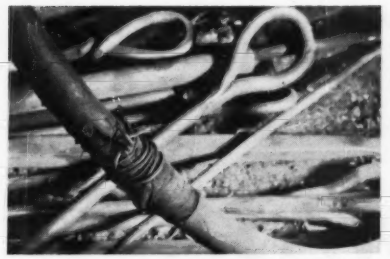
It goes without saying that the right hose for the job must be selected. Manufacturers' recommended pressures should be strictly observed. Forcing too much air through the line at too great a pressure to achieve full air power at the working end leads to breakdown of the hose and blowouts. If not enough air is getting to the tool, the entire system should be inspected. Leaks, insufficient compressor capacity, improper use of regulators, and overloaded or overextended lines are the reasons for costly low pressure. Air engineers can be consulted to work out a better system.

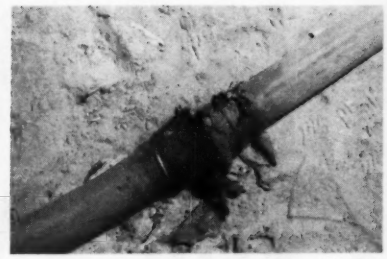
When selecting hose, consider the fluid it will carry, the working pressures it will be required to handle and the conditions under which it will be used. After purchasing the right industrial hose, keep it for its designed single purpose. Substituting a hose to transport fluids other than those recommended results in needless strain and destructive action.

Quality industrial hose is superior to that produced a few years ago. Like pneumatic tools described in the foregoing articles, it is meticulously engineered and tested. It is designed to take rigorous handling and withstand abuse. However, also like pneumatic tools, it is not designed for excessive neglect and misuse. Bending it sharply to stop air flow breaks coverings and inner reinforcings. Injurious blowouts can follow. The same is true of jerking it when it is



PORTABLE CLAMPING A clamping fixture need not be large. This one is portable and suitable for small operations. It can also be bench-mounted. Where large quantities of hose are used, a reclamation center is advisable. It should include a large clamping machine. Hammers are not good in installing clamps.





GOOD VS. UNSAFE PRACTICE The photographs above show three makeshift hose connections that are both costly and unsafe. Unfortunately, they are too common. The picture right shows a typical high-pressure hose connection with lock-wire application, using a 2-groove nipple and two Punch-Lok clamps. The neatness and smoothness are obvious; they pay off in money saved.

caught on machinery, or twisting and stretching it to make the hose pliable. Leaving hose on the floor where it is liable to be run over with fork trucks, where sharp objects can fall on it, where burning embers from welding and metal-cutting operations can eat through the fabric coverings are misuses that ought to be eliminated.

Do not drag hose over rough areas or subject it to needless abrasion. Overhead balancers are good here. For example, a grinder operator may cradle his tool in his arm while making a minor adjustment. The hose can easily rub against the wheel. If an overhead balancer is used, the hose will be up, out of the way.

Industrial hose that is submerged in fluids during use should have rubber-capped ends. This prevents fluid from soaking up through the carcass, which would eventually lead to a breakdown of adhesion of all parts.

Hot oil from compressors tends to buckle linings inwardly, breaking the adhesion to the carcass. This leads directly to porosity and cracking. A proper aftercooling installation is necessary.

After use, hose should be cleaned and drained. Manufacturers' instructions must be followed—often soap and water is the best method.

Never jam the free end of hose into sand or dirt to stop air flow. This is both dangerous and wasteful. Which brings up the unpleasant subject of free air.

Clamps

Every efficiency engineer knows the amount of money that can be lost by letting air escape from the system. Major leaks are often caught, but many small ones are overlooked or put aside. Together they amount to a costly waste of money in air power budgets.

It has been estimated that a single leak, $1/64$ inch in size, wastes 17,460 cubic feet of air (at 100-psig pressure) a month. At 10 cents per 1000 cubic feet, this amounts to $1.75 a month. A $3/8$-inch opening wastes 8,000,000 cubic feet per month—or $800 for every leak of this size. At these figures it is obvious that each leak is expensive by itself. When there are many, they can become financially disastrous.

Leaks often occur at hose connections. Therefore these should be selected to provide the best possible joint. A variety of suitable clamps are on the market and necessary sizes should be kept in stock. Makeshift ones are not good. In selecting an industrial hose clamp, look for light weight, simple installation, strength, uniform clamping action, and permanency. Sharp protrusions should be avoided; these might puncture hose or injure workers. Once good clamps are found, these should be standardized throughout the factory.

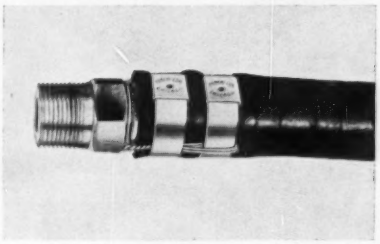
Both makeshift and standard hose clamps are illustrated here. The advantages of the latter are obvious; unfortunately a walk through many manufacturing plants often shows the other to be common.

Clamping kits are a boon to maintenance crews. One manufacturer provides the handy one shown here. It contains an assortment of 45 standard clamps and a portable Loking tool. This is just one of a variety of clamping devices that range from these small portable units to larger stationary ones that can speed up hose clamping when many joints must be made. The larger variety can be set up in a hose reclamation center when the amount of hose is considerable. Smaller operators, who are not immune to the problems of air leaks around clamps, can use the portable or bench-mounted models.

Another manufacturer has found an Impactool is valuable to help in mass-producing secure buckle clamps. The Impactool is equipped with a special adapter to draw the clamp up tight, fasten it securely and cut off the excessive metal banding.

Couplings

Another major area to be checked for hidden small leaks is around couplings.



Those that are installed at the factory are tested for tightness at working pressures.

It is sometimes necessary to install a coupling in the field or on the manufacturing floor. Then certain basic principles should be followed. A tight fit is necessary. The nipple and inside of the hose should be lubricated with a soapy solution if fitting it is too difficult. Never use oil or grease on couplings. Hose should not be cut out with a knife to facilitate fitting. Rather the end must be cut squarely. Inspect the coupling for burrs and serrations. When these are off, the coupling can be placed in a vise and the hose forced over the sleeve as straight as possible. Hammers of all sorts should be avoided. They will break the hose reinforcing.

Following these simple rules for maintaining industrial hoses, clamps and couplings will lead to a better air system, higher tool output and extended air dollars.

—S.M.P.

CLAMP-MASTER KIT Forty-five standard Punch-Lok clamps, both preformed and open-end, and a Loking tool are included. Use of such kits is ideal to prevent losses of compressed air from faulty clamping.

THE GOOD SHIP "WASA"

MUDDY and black, but a priceless piece of history, the old Swedish man-of-war *Wasa** broke the surface of the water Monday afternoon, April 24, 1961, after having rested for 332 years, 8 months and 14 days on the bottom of Stockholm's harbor. This historic event has been followed internationally. The Monday "launching" was no exception. It was witnessed by a crowd of experts from many nations from aboard the salvage fleet, and by thousands of Stockholmers who lined the shores reminiscent of her gala, though calamitous, maiden voyage on sunny August 10, 1628.

The approach of the seventeenth-century vessel into the twentieth has been slow, but exciting. Little by little she became visible and finally, with trumpet calls and drum rolls, was greeted by the Swedish Navy as by far its oldest vessel (*see photograph, upper right*).

The upper deck consists mainly of transversal heavy oak beams, most of which were broken during "gun fishing" in the 1700's, described in *Compressed Air Magazine,* November 1959. The outside planks seem to be in good condition, though, as are the lower decks. Details attracting special interest as the ship surfaced were four sculptured bitts, or "jacks," each having the form of a man's head. They were immediately wrapped in plastic to protect them from too rapid drying. This technique, as well as others from a variety of scientific fields, has been used to preserve the artifacts already retrieved (*Compressed Air Magazine,* October 1960). These jacks are visible in the lower right photograph. The discoverer Anders Franzen is at right in that picture and also is shown on this page. He located the oak hull in 1959 and was first aboard when she surfaced. He was followed by chief diver Per Edvin Falting.

After having been brought to sheltered, shallow waters by Neptun Salvaging Company, the ship is undergoing bailing. Although afloat, the *Wasa* will be assisted by salvage pontoons until she is completely dry-docked on a specially built pontoon-caisson.

Wasa's voyages have been unique in the history of the sea. The first (1628) lasted but a few hours, then she sank. The second was in August 1959, her broken bowsprit turned back once again toward shore and the 28-day trip being made under water. Her most recent journey was this month. It was a triumphant tour of Stockholm harbor, with salutes by units of the Swedish Navy and a visiting U. S. cruiser. She was then towed to a special site on Djurgarden Island. There she will be carefully excavated and examined in a temporary structure, gradually turning into one of the most unique maritime pieces in the world.

Measuring about 185 x 66 feet, the mighty superstructure of the pontoon-caisson on which the *Wasa* rests at Djurgarden will be given a nautical character, conforming to the ship's lines. The walls will have a pronounced inward slant, while the ship's sheer, with high stem and stern, will be emphasized through the upward longi-

* Wasa is the spelling adopted by the official committee responsible for the operations.

She was built to bolster the Swedish Navy during the Thirty Years War, 1618–1648; now she is doing the same for national pride because she floats again

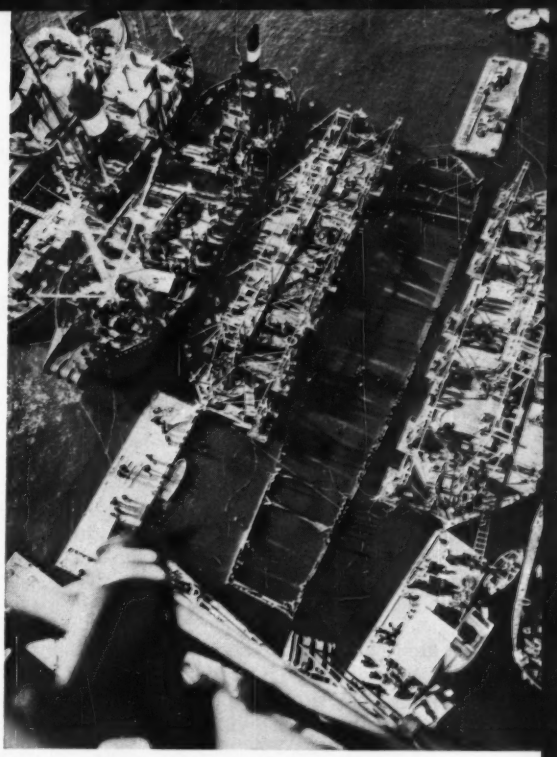
tudinal curve of the roof. Thus the temporary museum—for the *Wasa* will remain here for 6 to 8 years—will fit into its background of parks and naval base establishments on the capital's waterfront.

The superstructure, designed by Stockholm architects Hans Akerblad and Bjorn Hovander, is basically steel, weighing 100-120 tons. It is divided into 200 compartments by means of watertight bulkheads that increase stability and facilitate the trimming of the pontoon. Roof and walls are insulated, the latter being partly glazed and provided with sun shutters to prevent the ship from drying too fast. This would result in cracks and cellular collapse in the old wood. Ample ventilation and air conditioning equipment is being installed to keep the humidity at 95 percent during the initial rehabilitation. It will then be lowered gradually, always coming to rest at scientifically controlled levels. Work on the caisson-museum was done at Gavle Shipyard.

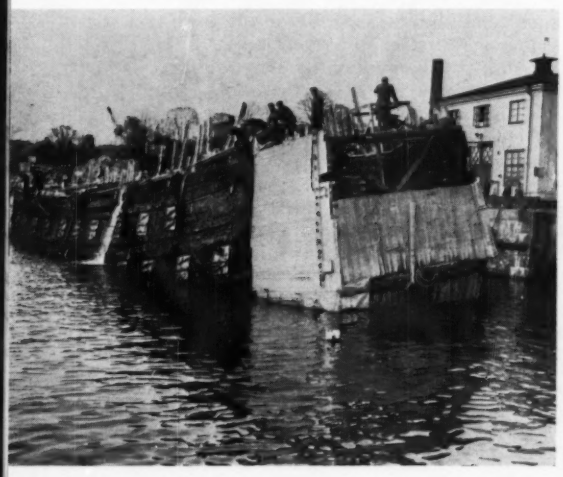
Archaeological investigations, preservation steps and reconstruction to some extent of the ship will take place in the museum. There is ample space for this work on the pontoon deck, and there will be mobile platforms along the ship's sides.

Visitors, who enter the building via a covered gangway (the museum being moored about 65 feet offshore), may inspect the *Wasa* from a gallery placed at the height of her waterline. There will also be an upper observation platform from which it will be possible to follow the scientific work in the interior of the ship.

A special exhibition ground is being arranged on the Djurgarden shore where selected finds will be on display. In addition, there will be workshops, administration buildings, a cafeteria and a lecture hall with a seating capacity of 250. It is hoped that the latter will be equipped with a closed-circuit television from the ship's workshop-museum to satisfy armchair archaeologists.



Inspired by the many interesting finds made during the salvaging of the "Wasa" a group of frogmen from Gothenburg have been engaged in their own salvaging scheme in the Archipelago off the west coast of Sweden. Two wrecks have been found: a Danish man-of-war "Sancta Sophia," which foundered in 1645 while attacking Gothenburg with a fleet of 25 vessels; and the Swedish East India liner "Lovisa Ulrika," which was shipwrecked 145 years ago. Neither can be hoisted to the surface like the "Wasa" since shipworms have completely damaged the crafts. However, several naval guns have been lifted, one bearing the monogram of Christian IV, King of Denmark at the time of the "Sancta Sophia's" foundering. During the initial diving operations several large cauldrons were brought up.



Extended Equipment Life

From Planned Maintenance

Improved Customer Relations

WITH more than $1 million worth of equipment for water-well and contract drilling, it is not unusual to find New Jersey Drilling Company, headquartered in Netcong, N. J., a maintenance-conscious organization. The firm's drilling operations extend from Massachusetts to Georgia, and include 95 percent of all drilling work in New Jersey quarries. With such a far-flung field and large capital investment, a continuous preventive maintenance program is an absolute necessity.

The company began a 3-year analysis of maintenance records in 1958 as part of an effort to learn the best time to undertake complete overhaul of drilling rigs, engines and compressors. To establish the normal engine service life, some diesels were endurance tested on the job for more than 9000 hours. One unit exceeded 12,000 hours. Four were ruined just because of the filters used.

Drilling equipment faces excessive dust conditions in putting down blast holes for quarries and major highway construction. Single-element filters that New Jersey Drilling had been using were found to be ineffective, particularly where high-silica-content dust was encountered. During the maintenance analysis tests, this grit passed through the filters. Two of the ruined engines operated for about 3000 hours; another, for less than 2000 hours. The fourth unit was only 2 months old. This equipment destruction was a severe blow to the company, for rigs were in continual demand and their availability was sharply reduced by a simple filter failure.

A change was necessary. Two-in-one Purolator filters were tried. Favorable results brought an immediate change on all drilling rigs. Now these dry-type filters are included in the routine maintenance program.

Testing further showed that a certain degree of metal fatigue appeared after 7500 hours. The amount of fatigue increased proportionately to additional service. The 5000-hour mark was eventually decided to be the optimum point to make complete equipment overhauls, although another 2500 hours of service could be obtained from an engine without undue strain. Since customer service is especially important, the safety margin this assures means that only top-performing drill rigs would be in the field.

Here is how the maintenance system operates. Daily reports filed by drill operators from all points on the eastern seaboard where rigs are operating record all maintenance performed on a machine. After the reports have been checked, the data are transferred to a master maintenance record at company headquarters. A complete maintenance schedule is provided each driller so he may perform prescribed treatment after every 8, 24, 50, 100 and 500 hours of operation. Every drill operator is trained in preventive maintenance. Every man can take apart any of the thirteen company-owned Ingersoll-Rand Drillmaster rigs and put it back together.

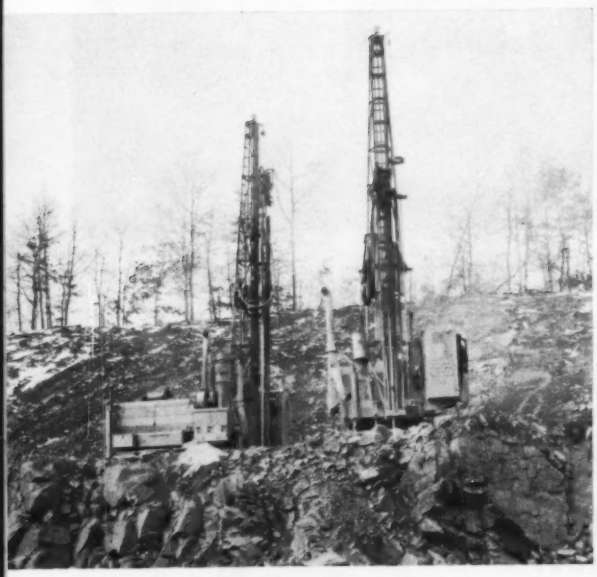
Maintenance performed after 8 hours of operation includes filling air line lubricators with drill oil, draining accumulated water from separators on the compressors, and checking both the oil level in the compressor system and engine crankcase and the water level in the radiator. Other maintenance at this time involves such parts as the gear box, hydraulic jacks, feed chain sprockets, oil cooler and fuel and oil filters.

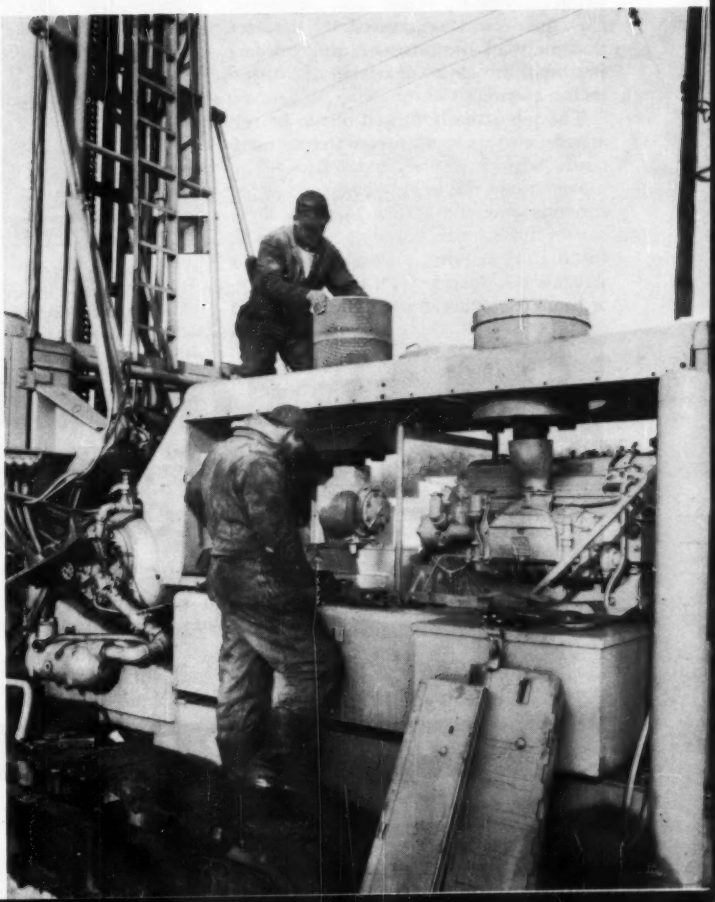
All fittings are greased every 24 hours. After 50 hours of operation, engine oil is applied to the compressor regulator arm and linkage and to the generator. The compressor oil filter is serviced and the air hoist gear chamber checked, oil being added if required. At the 100-hour interval, extensive grease and oil is programed for all subsidiary motors.

The 500-hour maintenance check calls for inspection of the primary filter element. (The two-in-one filter consists of a large treated-paper element, which performs primary filtration, and a smaller secondary element.) The primary element is usually clean and does not need replacement. In addition to this inspection, compressor lubricating oil is checked; the fuel filter and strainer element are replaced; the engine water hose is looked at for rot; generator brushes, commutators and belts are checked; and the engine air box is cleaned. An oil change is also made on the feed motor unit, propelling motors, dust-collector blower gear box, air hoist motor, and the rotary drill head. At the 1000-hour service period the primary filter element is replaced whether it is necessary or not. The secondary filter is replaced during the 2-year, or 5000-hour, servicing when drilling rigs are completely rebuilt.

Careful maintenance is performed on this regular basis, for service is an integral part of a contract drilling operation with drilling rigs as widely dispersed as those of New Jersey Drilling Company's. Each rig, with drill operator and helper, is contracted to quarry operators for specified time periods based on the number of holes required and drilling time needed. Such an arrangement relieves the quarry operator of any such responsibilities inherent in drill rig ownership, as maintenance, repair, transportation and restriction of operations because of down time on a rig. Another important aspect of this particular program is that it increases the quarry operator's working capital since he does not make any capital investment in a drilling rig and he doesn't have to expand his payroll. In March of this year, the New Jersey Drilling Company was able to boast 2 years of trouble-free service.

MAINTENANCE/ON THE JOB **At top, general view of outdoor maintenance area at New Jersey Drilling Company, Netcong, N. J. At right, maintenance foreman places dry-type Purolator filter in housing during 1000-hour check. Drillmaster operator in foreground performs required maintenance on rig. Scheduled maintenance keeps thirteen Ingersoll-Rand Drillmasters on the job—from Georgia to Massachusetts. At left, New Jersey Drilling Company owned rigs are at work on a road construction job near Wharton, N. J.**





Down Time Decreased With

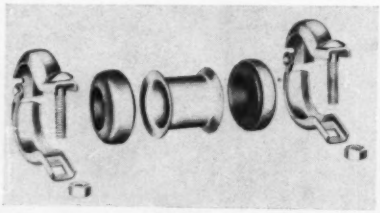
Simple Pipe Joints

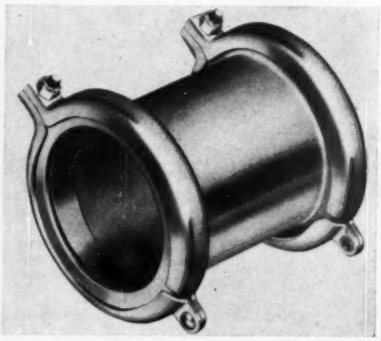
A WEST COAST manufacturing plant was recently faced with a breakdown in its process water pumping system. The system supplied 43 key machines, mainly welders, degreasers and induction heating equipment. The bottleneck stoppage could have resulted in a 75 percent shutdown of production facilities because the plant's operations are organized interdependently. It was important that the breakdown be repaired quickly for work centers had been loaded to peak capacity and the product could not be subcontracted.

A new and larger pump had been purchased at the time of the breakdown, and hydraulic engineers thought existing lines would not be adequate. They wanted to enlarge pipe diameters to allow an increase of water pressure and flow. It was estimated that with many conventional joints, this modification would have taken at least 24 hours. It would have required special equipment, such as pipe threaders, cutters, heavy wrenches, etc., not to mention the services of experienced plumbers from outside the factory organization. A large stock of nipples, unions and elbows had to be available. And the engineers' harassment was aggravated by the fact that many of the areas needing reworking were in close quarters, or buried in the ground.

The job actually turned out to be relatively easy. It was completed in 6 hours with just one maintenance employee doing the work. The reasons for this are inherent in the Marman Flexmaster pipe joints used. For example, installation is done with a simple hand wrench, eliminating such standard preparations as threading, grooving and flanging. Pipe is simply cut. The Flexmaster is then slipped over the two pipe ends and a single nut-and-bolt assembly tightened on each of these ends. Up to 4 degrees of misalignment can be tolerated and the seal is still perfect.

As for the anticipated enlargement of pipes, low friction through the Flexmaster brought the flow rates within acceptable limits. Four 90-degree elbows located near the pumping equipment were replaced with a combination of slightly curved lengths of pipe and the new couplings. This permitted a minimum of fluid friction and pressure drop. At the same time flow rates were increased by a reported 15 percent. Excavation of both shop and office areas to enlarge underground return lines became unnecessary. Thus the careful selection of the oft-overlooked pipe joint saved management many production dollars.





FLEXMASTER A typical Marman Flexmaster pipe fitting. Built of a pair of basic couplings, gasket assemblies and a single sleeve, the fitting can be ordered by individual components.

INSTALLATION These pipe joints prevented down time of 43 important machines and allowed emergency modification of close-quarter pumping system at a West Coast manufacturing plant.

New

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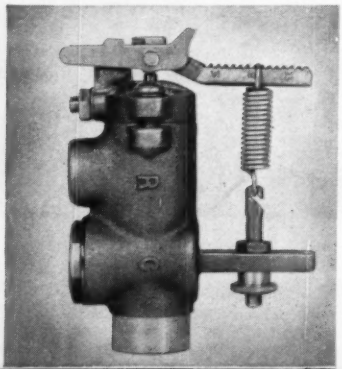


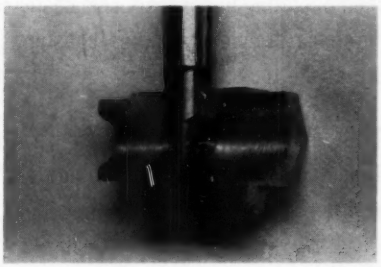
R. CONRADER CO., INC. BOX 924 · ERIE, PA.

Industrial Notes

THE SIZE 410 automotive air Impactool tightens or breaks nuts loose quickly and easily with 900 to 1000 impacts a minute when operated at 90 or 120 psig pressure, respectively. Fast run down is assured by free speeds of 4150 rpm at 90-psig pressure and 4500 rpm at 120-psig pressure, according to Ingersoll-Rand Company. The compact tool, which has a side to center distance of $1^{13}/_{16}$ inches measured to the shoulder of the square driver, is easily used on nuts in inaccessible locations. Its light weight of only $11^{5}/_{8}$ pounds reduces operator fatigue. Adjustable deflectors direct exhaust air away from the operator's face for greater comfort when working in close quarters. Pressure-fed lubrication increases the air tool's life and insures operation at top power. A newly designed reverse valve mechanism provides easier maintenance and prevents air leakage. A heat-treated steel casing protects the hammer against damage. Another feature is a built-in power regulator that permits the tool to be throttled down quickly and conveniently for running small nuts. The Size 410 Impactool has a $^{3}/_{4}$-inch square drive and can be supplied without accessories, or in a kit with $^{7}/_{8}$-, $^{15}/_{16}$-, $^{11}/_{16}$-, and $1^{1}/_{4}$-inch hexagon sockets, measured across the flats. The tool is also available in the same kit with a rugged steel carrying case. Extra equipment includes a universal joint and $^{3}/_{4}$-inch square drive hexagon and square sockets. *Ingersoll-Rand Company,* 11 Broadway, New York 4, N. Y.

TUBE-O-MATIC is a new approach in valve design and has been originated by Airmatic to solve the problems of valve wear and maintenance in controlling abrasive or corrosive fluids and gases. Four-page, illustrated Bulletin 91043 supplies descriptions, specifications, features, optional equipment, ordering data and dimensions. *Airmatic Valve Inc.,* 7313 Associate Avenue, Cleveland 9, Ohio.

THIS solenoid-operated shut-off valve, now in pilot production, has no organic parts. It also features lightweight construction, straight-through flow with little pressure drop and low electrical power requirements. According to the inventor, George A. Bier, the $^{1}/_{8}$-inch model weighs less than 2 ounces. Its rugged unitized body of aluminum and stainless steel integrates the line connection, chamber, seats and plunger sleeve. This means fewer assembled parts and the end of maintenance problems caused by organic seals such as O-rings, washers, gaskets and packings. Without organic seals, the valve may be used over a broad range of temperatures and pressures and with a wide variety of fluids.

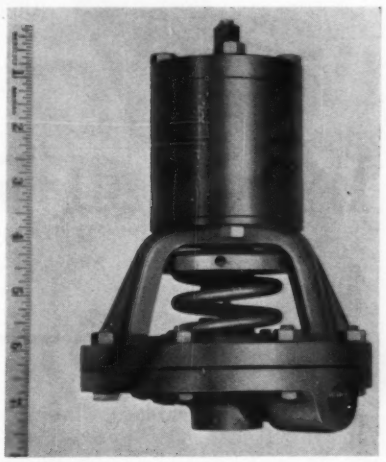


Port sizes from $^{1}/_{16}$ to $^{1}/_{2}$ inch are practical with the valve. Its straight-through flow feature permits small line sizes because turbulance and pressure drop are minimized. This low resistance to flow allows additional reduction in weight and cost by cutting operating power requirements for the valve. It may be made for either a-c or d-c operation. The valve's only movable parts are the plunger and sealing disc, both operating with low friction. This extends service life and reduces power requirements and maintenance even further. Several models are capable of withstanding pressures to 5000 psig. Further data may be obtained by writing to the attention of the inventor, George A. Bier. *Polymet Company,* Box 321, Orange, N. J.

CHOOSING recommended chain pitch sizes for power transmission chain is simplified by a quick-selection wall chart published by The Whitney Chain Company. Printed on heavy paper that is suitable for wall mounting or filing, the 2-color chart lists design horsepower on a vertical axis, and speeds (for the small sprocket) on a horizontal axis. Simply by locating the intersection of any two selected combinations of these factors automatically gives the recommended chain pitch size. Free copies of the chart may be obtained from the company. *Foote Bros. Gear & Machine Corporation,* The Whitney Chain Company, Department MJ, 4545 S. Western Boulevard, Chicago 9, Ill.

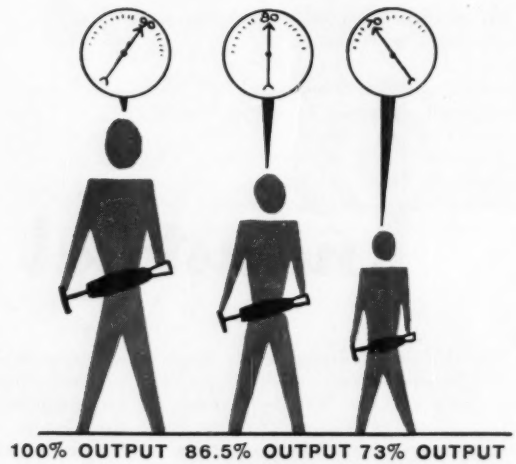
FASTENERS from $^{3}/_{8}$ inch to 2 inches in length and more than 100 guns to drive them are illustrated in a 16-page Spotnails catalog (B-115). Staples, tee nails, finishing nails and pins are described along with their uses. Any manufacturer who uses hammers and nails for crating, pallet repairs or manufacturing wood and fiber products can increase production by 500 percent with these new tools, according to the bulletin. The catalog is available from the company without charge. *Spotnails, Inc.,* Department I-15, 1100 Hicks Road, Rolling Meadows, Ill.

FOR SELECTING, diverting, piloting or cycling, a versatile pneumatic circuitry component has been designed by G. W. Dahl Company, Inc. It is the latest addition to its Mite Series of controls and provides positive, instantaneous, multi-circuit control in air and nontoxic gas service, according to reports from the company. Mite 75, as the unit is called, features independently adjustable trip-in and trip-out points that vary the dead band as desired. It snaps to the desired porting at predetermined limits. The



valve operates within a control signal pressure range of 3 to 30 psig, with a snap-acting mechanism operable when a minimum supply pressure of 10 psig is available at one or more of the three body connections. No bleed of air from the 3-way valve is required before

If your tools require a pressure of 90 psi, your production efficiency drops 13½% if pressure falls to 80 psi, and drops 27% if pressure goes down to 70 psig.



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LOW TOOL PRESSURE can result from inadequate piping, leakage or an overworked compressor . . . To find out quickly if you are getting full production from your air tools and equipment, ask today for a brief survey by a qualified I-R AIRengineer. You'll find one at your nearest Ingersoll-Rand Branch Office or authorized I-R distributor.

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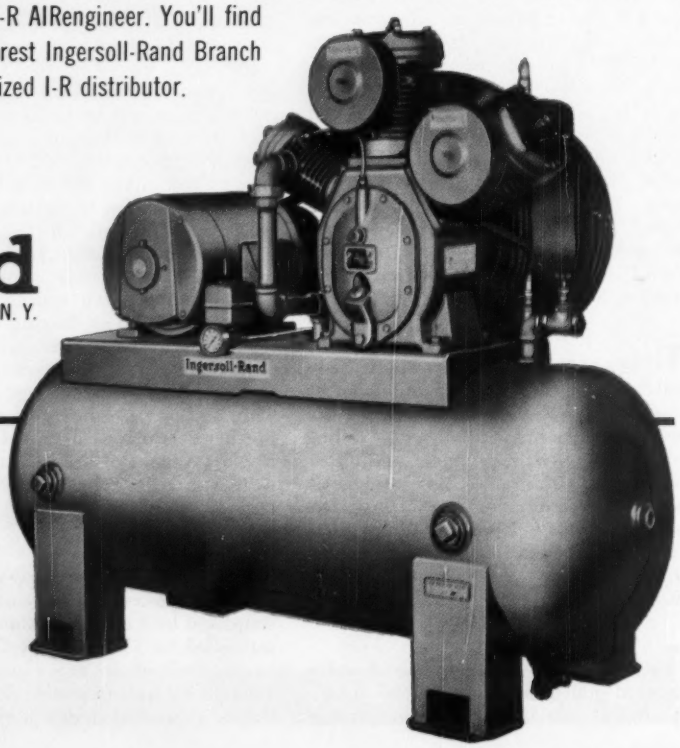


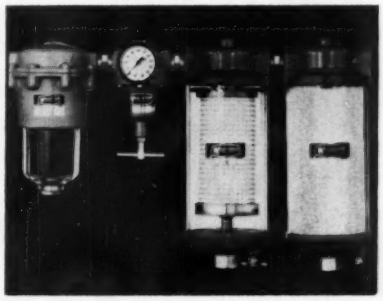
Ingersoll-Rand Type 30
Air-Cooled Air Compressor
½ through 20 hp

114A3

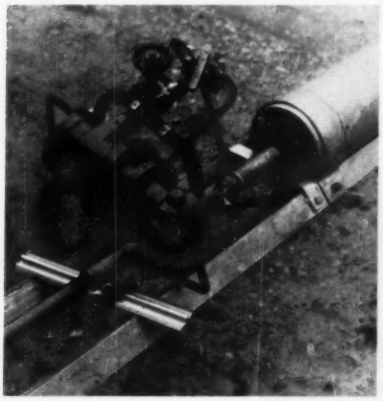
or after tripping. The valve body is rated at 100 psig maximum pressure; the operator, at 75 psig maximum. Mite 75 is listed for temperatures to 180° F. *G. W. Dahl Company, Inc.,* 60 Tupelo Street, Bristol, R. I.

OPERATION and application of the Skidmore-Wilhelm portable torque wrench calibrator is described in Bulletin 210. Designed for checking and setting all types of torque wrenches, the device may be bench-mounted or clamped in a vise. It needs no piping, wiring or other external connections. The unit measures both right- and left-hand torque, and is certified accurate within 1 percent of full-scale reading. The literature lists complete specifications and dimensional data for six models, covering torques to 2000 foot-pounds. Technical information is tabulated for easy-to-read reference. *Skidmore-Wilhelm Manufacturing Company,* 442 S. Green Road, Cleveland 21, Ohio.

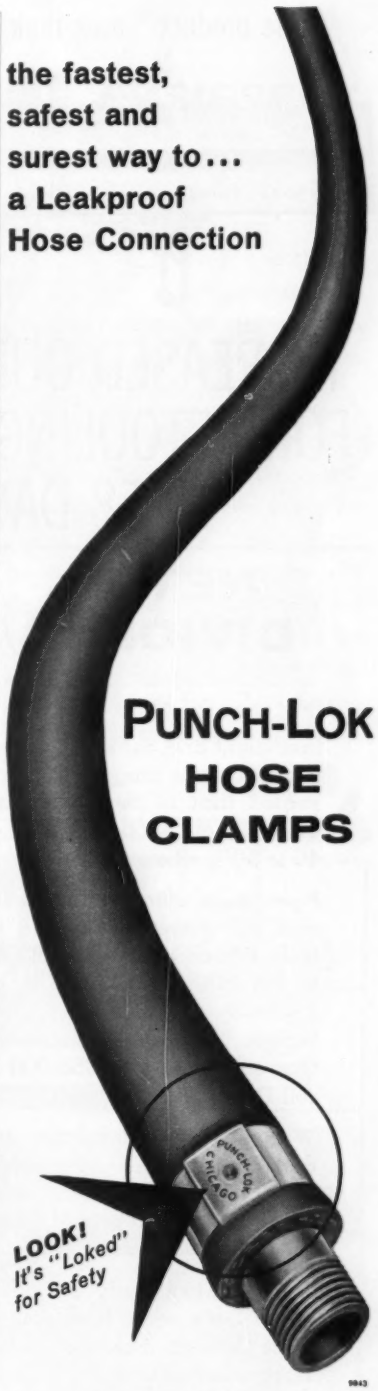
CHEM-GUARD dehydrators are intended for persons who do not need instrument-pure air throughout their entire plant. Because each dehydrator is made up of standard units packaged to fit exactly the individual needs of a particular application, it is said to be more economical to purchase and maintain than other units offered for lowering the dew point of compressed air. The first part of the package, for instance, is to remove entrained moisture and small particles of dirt. It is equipped with a built-in automatic drain to keep the accumulated contaminants drained off the line. The second part through which air travels is a precision air regulator for controlling pressure. This is followed by an air filter that removes oil fumes,



prohibiting them from coating the silica-gel dessicant in the last segment of the package. According to company reports, the dryer is capable of lowering the dew point of compressed air to —65° F. The package is available as shown, or with any one of the units omitted from it. Furthermore it can be tailor-made to fit any application. Rated at a maximum of 10 cfm at 100-psig pressure, the Chem-Guard will reportedly give long service life on either intermittent or continuous flows of air. It needs no draining, and



THE pictures above illustrate a lightweight drill designed primarily for underground exploration work. The unique unit consists of a frame, an air leg, and a drill powered by an Ingersoll-Rand 9MJ Air Motor. Drilling can be conducted at any angle with the unit. Large ore bodies can be pattern drilled to a depth of 150 feet and the rig is also suited to the conventional "long hole" or "ring drilled" methods of mining. An expansion eyebolt is affixed to the front of the frame so that the drill can be anchored, the rods broken, and the complete unit swung to one side. This feature is included so that the drill in operation won't have to close off a main haulageway. An improvement of an earlier model, the unit as now designed is said to have especially high stability and versatility and is easy on the operator. *Packsack Diamond Drill Company,* North Bay, Ont., Canada, is the originator of the unit and handles Canadian sales. *Acker Drill Company,* P. O. Box 830, Scranton, Pa., under license from the Canadian concern, is the manufacturer and dealer in the U. S.



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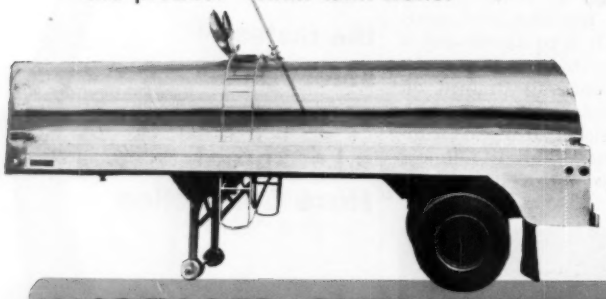

INCREASED OUTPUT PAYS FOR RETOOLING PROGRAM IN 58 DAYS...

NETS $58,000 DIVIDEND/YEAR!

Inefficient and outdated power tools were costing this plant money. A power tool study revealed that in the assembly of tank trucks alone, 29 out of 66 tools were operating at only 40 to 50% efficiency.

New, more efficient Ingersoll-Rand Air Tools with full power and speed replaced the old tools. Fifteen additional I-R tools were installed to cut fabrication time on other operations. Leaks, faulty oilers and air filters were corrected. The net result: increased production that amounted to a $58,000 Dividend on Payroll Dollars the first year.*

With production increases making up the full cost of the tool replacement program in just 58.6 working days, an immediate Planned Annual Retooling program was started to maintain peak tool efficiency and maximum output.

A power tool study in your plant can more than likely show how you can reduce your costs through increased output per man with more efficient tools.

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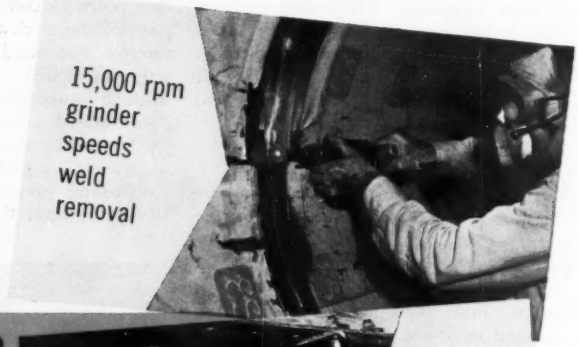
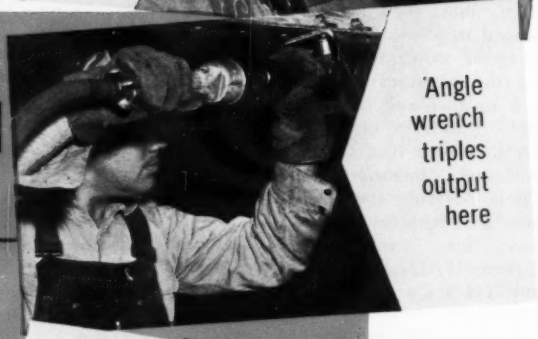
216A-8

Ingersoll-Rand

Planned Annual Retooling increases output per man



15,000 rpm grinder speeds weld removal



Angle wrench triples output here

Bolt assembly time cut by 67%

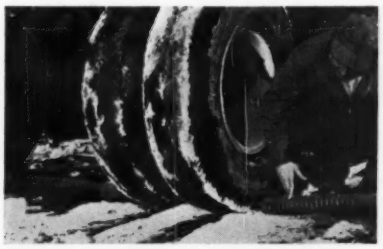
Impactool cuts die changing time in half

5 man-hours a tank saved running self-tapping screws

no water or electrical connection. The dehydrator doesn't need to be reactivated, though it can be. Chem-Guards are ideal for installation before paint spraying operations, pneumatic instruments, air-operated gauges, where air is used in glass blowing or making plastic bottles, and similar pure-air applications. *Wilkerson Corporation,* 1645 W. Mansfield, Englewood, Colo.

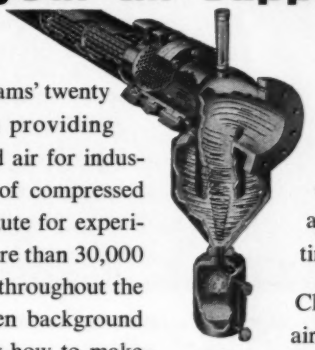
STANDARD coated abrasive products used throughout industry are listed in "Catalog of National Standard Abrasive Belts, Rolls, Sheets and Discs." All items cataloged are maintained in stock at Carborundum warehouses. Electronic order processing and inventory control, together with the use of standard catalog items, help cut customer's costs and expedite service. *The Carborundum Company,* Department BMD, P. O. Box 337, Niagara Falls, N. Y.

A WATER SUCTION hose designed especially for use where tubes are subject to damage from truck movements is on the market. Identified as Rebound because it springs back to its original shape even if completely crushed, the hose is produced in lengths to 50 feet and with inside diameters of $1^1/_2$ to 3 inches. The shape of the line is maintained by a treated rope helix embedded in heavy rubber between two plies of



fabric reinforcement. The helix also prevents collapse of the hose at high vacuum. The interior tube of Rebound is a nonporous rubber compound that is

Specify an ADAMS aftercooler for your air supply...



and benefit from Adams' twenty years experience in providing clean, dry compressed air for industry. In the handling of compressed air, there is no substitute for experience. Adams, with more than 30,000 installations in plants throughout the world, have the proven background and engineering know-how to make the best recommendation for your plant needs to insure a clean, dry compressed air supply.

By assembling mass-produced components to your specifications, Adams is able to pass substantial savings on to you . . . without reducing product quality. Your initial equipment cost is lower and the recurring savings in reduced maintenance and production downtime are infinite.

Check your compressed air system. If the air delivered to your equipment is not top quality, you need an Adams Aftercooler. Bulletin 715 is complete with design diagrams, capacity charts and installation photographs. Write for your copy today. R. P. Adams Company, Inc., 209 East Park Drive, Buffalo 17, New York.

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"PRECISE POWER"
BY CONTINENTAL
MORE POWER TO YOU
IN CONSTRUCTION

CONTINENTAL MOTORS · Powerful as the Nation · AMERICA'S STANDARD ®

"More Power to You" is a four-word summary of Continental's stock in trade. And actually, it tells only part of the story, for Continental provides not only MORE but BETTER power—power that is engineered precisely to its job. Continental builds one or more engine models—for use on all standard fuels—for construction jobs of every type and size. The unmatched breadth and diversification of the Continental line assures precise Red Seal power for every construction application. Not only in this field, but on farm and ranch, in industry and transportation—

MODEL F-226 (Gasoline)
INDUSTRIAL CLOSED POWER UNIT
73 H.P. at 2400 R.P.M.

ANY EQUIPMENT IS BETTER WITH DEPENDABLE CONTINENTAL POWER

Continental Motors Corporation
MUSKEGON, MICHIGAN

said to resist action of sand and grit and also is impervious to mildly acid or alkaline water. While stocked with straight ends only, it also can be furnished with enlarged ends. *Goodyear Tire & Rubber Company,* Akron 16, Ohio.

Books . . .

1960 Supplements to Book of ASTM Standards (published by American Society for Testing Materials, 1916 Race Street, Philadelphia 3, Pa.) are now available. Each Part-supplement brings up-to-date the corresponding Part of the *1958 Book of Standards* and the 1959 supplements by including new standards and revisions adopted in 1960. Latest forms of standard specifications, tests, definitions, and recommended practices are included. The *Standards* is published triennially, with annual supplements issued for each of the ten parts of the book. Each of the 1960 supplements is bound with heavy paper cover. Cost, $4 per part; $40 per set.

Part 1: Ferrous Metals Specifications. 444 pages.

Part 2: Nonferrous Metals Specifications and Electronic Materials. 348 pages.

Part 3: Methods of Testing Metals (Except Chemical Analysis). 180 pages.

Part 4: Cement, Concrete, Mortars, Road Materials, Waterproofing, Soils. 240 pages.

Part 5: Masonry Products, Ceramics, Thermal Insulation, Acoustical Materials, Sandwich and Building Constructions, Fire Tests. 238 pages.

Part 6: Wood, Paper, Shipping Containers, Adhesives, Cellulose Leather, Casein. 212 pages.

Part 7: Petroleum Products, Lubricants, Tank Measurement, Engine Tests. 320 pages.

Part 8: Paint, Naval Stores, Coal and Coke, Aromatic Hydrocarbons, Gaseous Fuels, Engine Antifreezes. 210 pages.

Part 9: Plastics, Electrical Insulation, Rubber, Carbon Black. 494 pages.

Part 10: Textiles, Soap, Water, Atmospheric Analysis, Wax Polishes. 334 pages.

Conversion Factors and Tables (published by Industrial Research Service, Inc., Masonic Building, Dover, N. H.) is now in its third edition. It is compiled by Dr. O. T. Zimmerman and Dr. Irvin Lavine, both of the University of New Hampshire. The present edition has been brought up to date with new conversion factors and recalculated factors based on the latest and most accurate fundamental data. There are thousands of conversion factors: weights, velocities, densities, pressures, energies, heat-transfer, power, thermal . . . to name a few. Most technical men are familiar with the publication and find its handy $4^1/_4 \times 6$-inch size a major advantage in its use. It is hard to imagine any desk without a copy—either in the office or at home. If your edition is dog-eared from use, as is ours, the third edition will be welcome. 710 pages. Cost: $7.50, domestic; $8.25, foreign.

Soviet Refrigeration Technology (published by Pergamon Press Inc., 122 E. Fifty-fifth Street, New York 22, N. Y.; Headington Hill Hall, Oxford; 4 & 5 Fitzroy Square, London W.1; 24, Rue des Ecoles, Paris V; or Kaiserstrasse 75, Frankfurt-am-Main) by D. N. Prilutski, was translated by V. Alford. The book is a bibliographical reference, divided into three parts. The first deals with project and design engineering and the technical operation of refrigeration plants and installations. The second covers the treatment and transport of food products, the applications of refrigeration in different branches of the economy. The third deals with technology and engineering or refrigeration and air conditioning. The publisher will furnish translations of any article referred to in the bibliography at a nominal fee under a cost-sharing plan. 135 pages. Cost, $10.

NON-FLUID OIL TRADE MARK REGISTERED PROTECTS PNEUMATIC POWER UNITS FROM RUST AND CORROSION

Ordinary lubricants cannot prevent air-borne moisture from attacking pneumatic power units and impairing their efficiency. However, the "NR" grades of NON-FLUID OIL were specifically designed to emulsify permanently with moisture and work to protect internal surfaces from rust and corrosion, sticking and gumming.

Pneumatic power unit manufacturers use and recommend "NR" grades of NON-FLUID OIL on their equipment to insure top power and operating efficiency. Hundreds of major pneumatic power unit users insist on "NR" grades as their lubricant.

You will understand why if you write today for a free testing sample of the "NR" grade of NON-FLUID OIL and Bulletin 550.

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NON-FLUID OIL is not the name of a general class of lubricants but is a specific product of our manufacture. So-called grease imitations of a NON-FLUID oil often prove dangerous and costly.

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AIR METERS

5 Ranges Covering from 4 to 450 CFM

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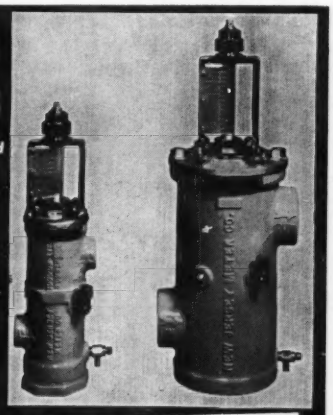
- RELIABLE AND DURABLE
- PORTABLE FOR FIELD TESTING
- ACCURACY ±1%



New Jersey Air Meters measure the air consumption of any pneumatic tool, drill, motor, sand blast, or other pneumatic device or process. Air consumption is the "pulse" of the condition of air equipment. With New Jersey Air Meters you can select the most suitable equipment for your particular service, maintain this equipment in effective working condition and eliminate the "air-eaters" when they have become obsolete. KEEP YOUR PRESSURE UP AND YOUR AIR COST DOWN WITH SIMPLE, RELIABLE, PORTABLE, ACCURATE AND CONVENIENT NEW JERSEY AIR METERS. TECHNICAL BULLETINS AVAILABLE UPON REQUEST.

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CLARK, NEW JERSEY

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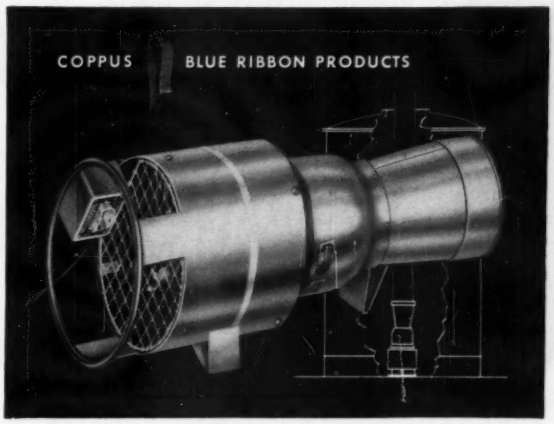

COPPUS "Blue Ribbon" Ventilator-Blowers are portable and easily adaptable . . . for supplying fresh air or discharging foul air or fumes. Mail coupon below for facts.

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- ☐ in tanks, tank cars
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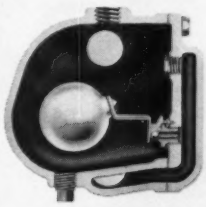
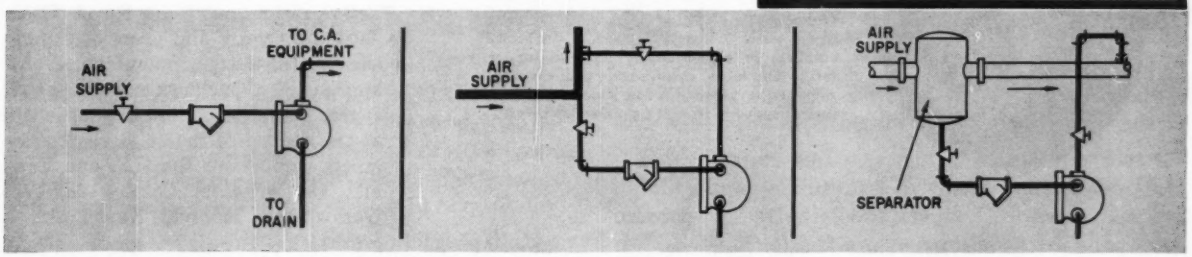
Get more work from your CA tools with NEW SARCO FA DRAIN TRAPS



Cross-section of Type FA Drain Trap shows float design that keeps condensate level above trap, providing seal against air leakage.



The true measure of effective air compressor capacity is effective work done by your compressed air tools. These tools will perform *more* useful work when you install Sarco Automatic Drain Traps. Typical hookups above show how Sarco Type FA Traps keep condensate level in the trap body *above* the valve.

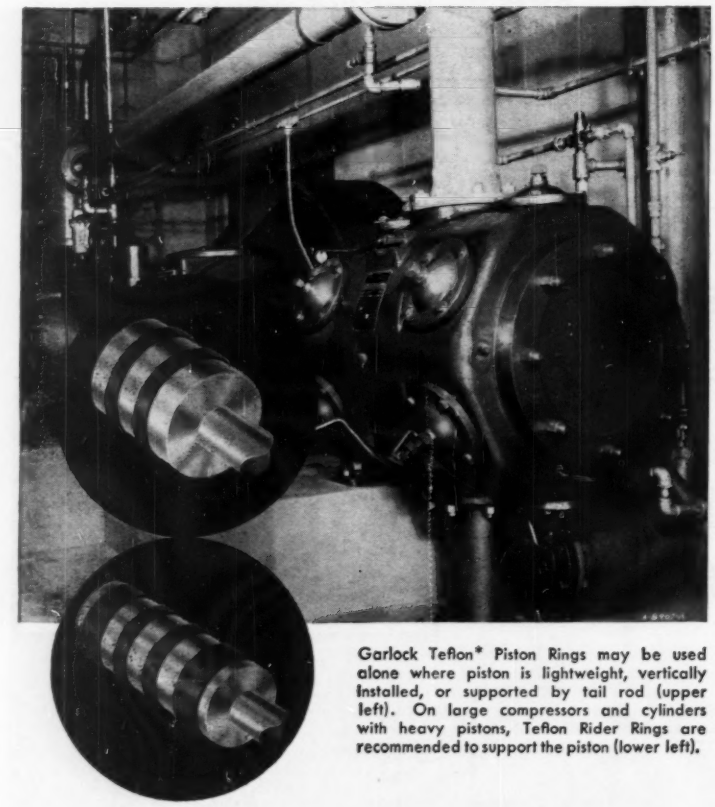
They maintain positive seal against air leakage and give you the steady supply of dry air that means full power. Dry air also cuts maintenance . . . prevents damage to tools from water hammer and impaired lubrication . . . and prevents the freezing in the tool exhaust that can mean slowed production. Write for Bulletin 520, full of ideas that can help increase effectiveness of your present air compressor capacity. 6351

SARCO

SARCO COMPANY, INC.
635 MADISON AVE., NEW YORK 22, N. Y.
PLANT: BETHLEHEM, PA.
STEAM TRAPS • TEMPERATURE CONTROLLERS
STRAINERS • HEATING SPECIALTIES

NEW ENGINEERED TEFLON PISTON RINGS

for Non-Lubricated Service



Garlock Teflon* Piston Rings may be used alone where piston is lightweight, vertically installed, or supported by tail rod (upper left). On large compressors and cylinders with heavy pistons, Teflon Rider Rings are recommended to support the piston (lower left).

Time after time, Teflon Piston and Rider Rings—the newest of Garlock products—prove effective in extending ring life under non-lubricated or chemical service.

A compressor used in wet hydrogen service was fitted with six rings of Teflon. Lubrication was eliminated and the rings were still in service after 2000 hours. Cast iron piston rings previously used needed lubrication and lasted less than 100 hours.

Another compressor operated at +350°F to supply instrument air. With Teflon Piston Rings, the compressor has been in continuous service for over 2500 hours without lubrication; the radial wear rate is approximately .009 per 1000 hours. Before this, the cylinder had to be lubricated; it was also necessary to periodically remove oil from the discharge air to prevent entry into instrument air lines.

The first really satisfactory piston rings for non-lubricated service, Garlock Teflon Piston and Rider Rings are engineered for longer life and better heat dissipation. They have the lowest coefficient of friction of all materials, are chemically inert, and will not contaminate the gas or fluid in the system. Garlock Teflon Piston and Rider Rings will not crack or break, will not score cylinder walls, and are flexible for easy installation. They can be applied at temperatures from −420°F to +500°F, are available in carbon-graphite filled Teflon or glass-filled Teflon, and come in either butt joint, step joint, scarf cut or solid, depending on your needs.

Talk to your Garlock representative about Teflon Piston and Rider Rings. He is backed by years and years of experience in the design, manufacture and application of packings and seals of all types. You will find him in your locale at the nearest of the 26 Garlock sales offices throughout the U.S. and Canada. Or, write for Catalog AD-178. Garlock Inc., Palmyra, New York.

GARLOCK

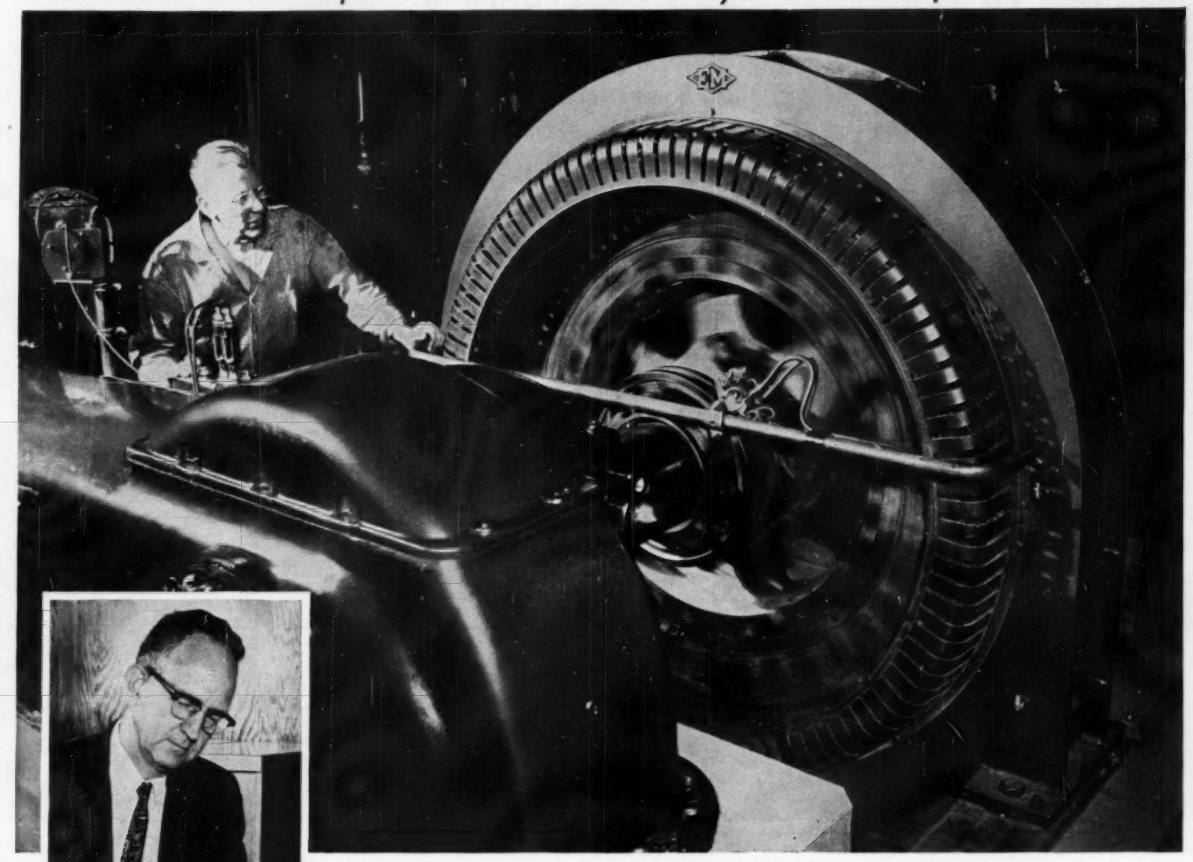
Canadian Div.: Garlock of Canada Ltd.

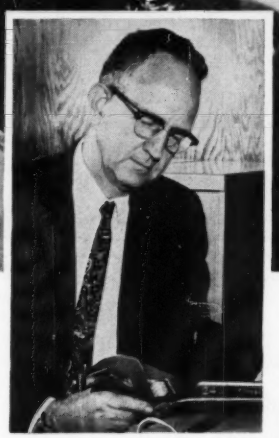
Plastics Div.: United States Gasket Company

Order from the Garlock 2,000 . . . two thousand different styles of Packings, Gaskets, Seals, Molded and Extruded Rubber, Plastic Products.

*DuPont Trademark

E-M Motor starts equivalent of second 50 years of compressor service!





After running approximately 108,000 hours, this E-M Synchronous Motor is still on compressor duty at Diamond Tool and Horseshoe Co. Contributing to the remarkably long life of the motor was the careful attention of Mr. J. Gordon Mitchell (above), Diamond Tool's electrical maintenance man. The motor is rated 350 hp, 200 rpm, 1.0 PF, 440 volts.

Mr. Hampton Connell, Vice President, Engineering, of Diamond Tool and Horseshoe Co. His company recently celebrated its 50th Anniversary as a manufacturer of hand tools and drop forgings.

"We just can't seem to wear them out!"

Diamond Tool and Horseshoe Co. of Duluth, Minnesota has an E-M Motor on compressor drive that has been running for the equivalent of *40 hours a week for over 50 years—approximately 108,000 hours!* Yet this same motor is still in service 16 hours a day.

Mr. Hampton Connell of Diamond Tool tells this unsolicited story about his untiring E-M Motor:

"This particular motor was installed about 1942, and was in service 24 hours a day, 7 days a week during the last war. Following the war we operated this unit 24 hours a day, 5 days a week for a considerable period of time. For the past several years we have been running the machine 16 hours a day, 5 days a week.

"We have been using E-M Motors in our factory on our air compressors for a good many years now, and with very satisfactory results."

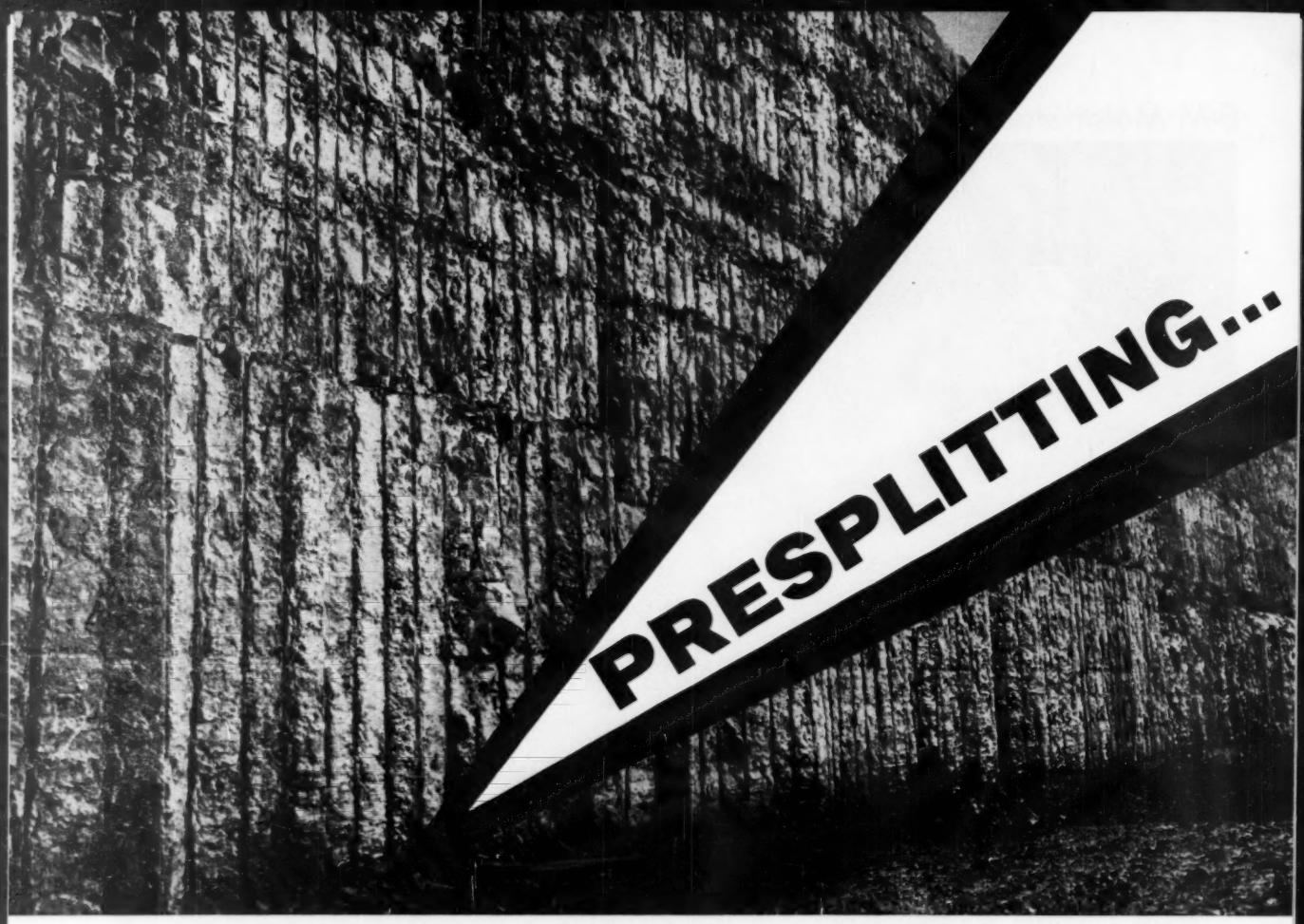
E-M Motors have earned a reputation for reliability and endurance in many industries. Get more information about them. Call your nearby E-M Sales Engineer and write the factory for free Compressor Number of E-M *Synchronizer*.

ELECTRIC MACHINERY MFG. COMPANY

MINNEAPOLIS 13, MINNESOTA

1200-TPA-2214

***Specialists in making motors do* EXACTLY WHAT YOU WANT THEM TO**



AN IMPORTANT NEW BLASTING TECHNIQUE PIONEERED BY HERCULES

PRESPLITTING is a forward step in the advancement of a more efficient blasting technique. This new method of controlled blasting, pioneered by Hercules Powder Company, produces "line-drilled" results without the excessively high costs of actual line drilling.

PRESPLITTING has the following advantages over normal methods of blasting:

1. Rock overbreak behind the PRESPLIT blast holes reduced to an absolute minimum—*less extra unpaid-for excavation and less concrete required because excess overbreak is eliminated.*

2. Fewer blast holes required than for line drilling—*extra dollar savings in drilling costs.*

3. Reduction in ground vibrations from primary blasting—*fewer complaints from nearby householders and industries.*

4. Sheer, clean rock wall obtained—*greatly reduced scaling time.*

5. Back shattering reduced—*much safer wall to work under; walls require less maintenance.*

6. Entire cut may be PRESPLIT with one blast—*saves resetting up time.*

Detailed technical information about PRESPLITTING is available in bulletin form. Ask your Hercules representative for a copy and learn how PRESPLITTING will reduce costs on your job.

Explosives Department

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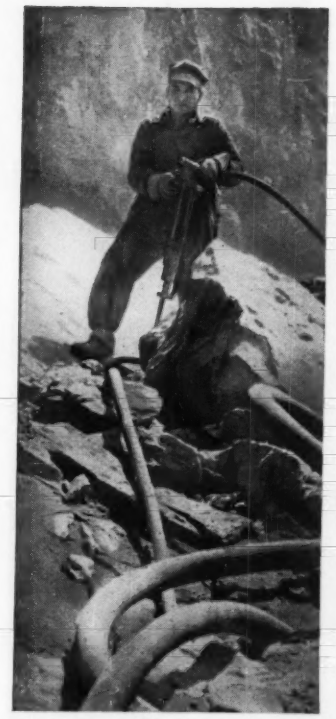

HOMOFLEX
AIR HOSE

"FLEXIBLE AS A ROPE"

- **STRONG**
- **LIGHT**
- **KINKLESS**

More flexible and lighter than any other hose for equal pressure. Lasts longer, precision built, uniform diameter, lower end cost. Made also in extra-heavy type for mining.

Write for Catalog M610.

RM 1014

Engineered Rubber Products . . More Use Per Dollar

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MANHATTAN RUBBER DIVISION, PASSAIC, NEW JERSEY

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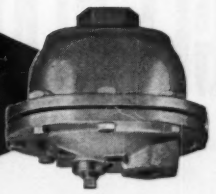
THE
"NO-TROUBLE"
AIR TRAP



THE ARMSTRONG NO. 21 BALL FLOAT AIR TRAP — GUARANTEED TO SATISFY OR YOUR MONEY BACK

For draining moisture from air lines, (drip pockets, small separators, small receivers, etc.) you can depend on the Armstrong No. 21 air trap for trouble-free service. It's built to the highest standards—guaranteed to satisfy. Can be used wherever no heavy oil or dirt is present. Check the features:

- **No Air Loss**—valve is always water-sealed.
- **Stainless Steel Parts**—float, leverage system and valve seat. Valve is heat-treated chrome steel.
- **Small, Compact**—Simple design, with a strong, cast semi-steel body.
- **Self-Priming**—no need to add water to start operation.

Bulletin Describes Complete Line of Armstrong Air Traps

Bulletin No. 2024 shows how to select air traps for any job. Gives dimensions, capacities and prices of all Armstrong air traps. For your copy, call your local Armstrong Representative, or write:

8853 Maple St., Three Rivers, Michigan

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GET REAL PRODUCTIVITY—GET A GM DIESEL

One look will tell you that this Ingersoll-Rand 315 Gyro-Flo compressor has had to work for a living.

And worked it has!

For over 9 years it has been on the job day in, day out, supplying air for drills and hammers in the Halquist Lannon Stone Company quarry near Sussex, Wisconsin.

In those nine years this GM Diesel powered unit has racked up over 40,000 hours—*been overhauled only twice* at approximately 18,000-hour intervals.

Mr. A. C. Halquist says, "The GM Diesel 3-71 in this compressor has had only minor adjustments in addition to two overhauls and still runs as good as new. It's one of the best pieces of equipment we ever bought."

If that's the kind of profit-making productivity you want from your equipment, specify a GM Diesel engine when you buy or repower. There's a model of the proper size and output for nearly every type of construction equipment.

For details see your GM Diesel Distributor* or write direct for your copy of the new booklet, "2300 Applications of GM Diesel Power."

**Listed in the Yellow Pages under "Engines, Diesel."*

GM DIESEL

DETROIT DIESEL ENGINE DIVISION,
GENERAL MOTORS, DETROIT 28, MICH.

In Canada: GENERAL MOTORS DIESEL LIMITED, London, Ontario
Parts and Service Worldwide

GM DIESEL ALL-PURPOSE POWER LINE sets the standard of Diesel productivity

NEW

NORGREN PRECISION PRESSURE REGULATOR

high sensitivity and exact accuracy of air pressure regulation

The new Norgren Precision Pressure Regulator, Type 20AS, is designed for air-gauging, laboratory use, pilot regulation and other applications where a high degree of accuracy and sensitivity is required for air pressure regulation. Operation of the new Type 20AS regulator is characterized by the following:

1. **Accurate regulation at all flows up to the maximum flow recommended for ¼" pipe. This is more than 2 times the flow previously possible with instrumentation regulators.**
2. **Immediate response and high sensitivity.**
3. **Exact repeatability and freedom from drift over short or long time operations.**
4. **Accurate regulation—even at delivery pressures below 1 psi.**

SPECIFICATIONS:

0-60 psig secondary pressure
0-150 psig primary pressure
32° to 160° F temperature range
¼" pipe size

This regulator was demonstrated at our booth in the
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Detroit, May 22-25.

For complete technical information about the new Norgren Precision Pressure Regulator, call your nearby Norgren Representative listed in your telephone directory—or write factory for brochure NA-7.

Founded in 1926

C. A. NORGREN CO.

3407 SOUTH ELATI STREET • ENGLEWOOD, COLORADO

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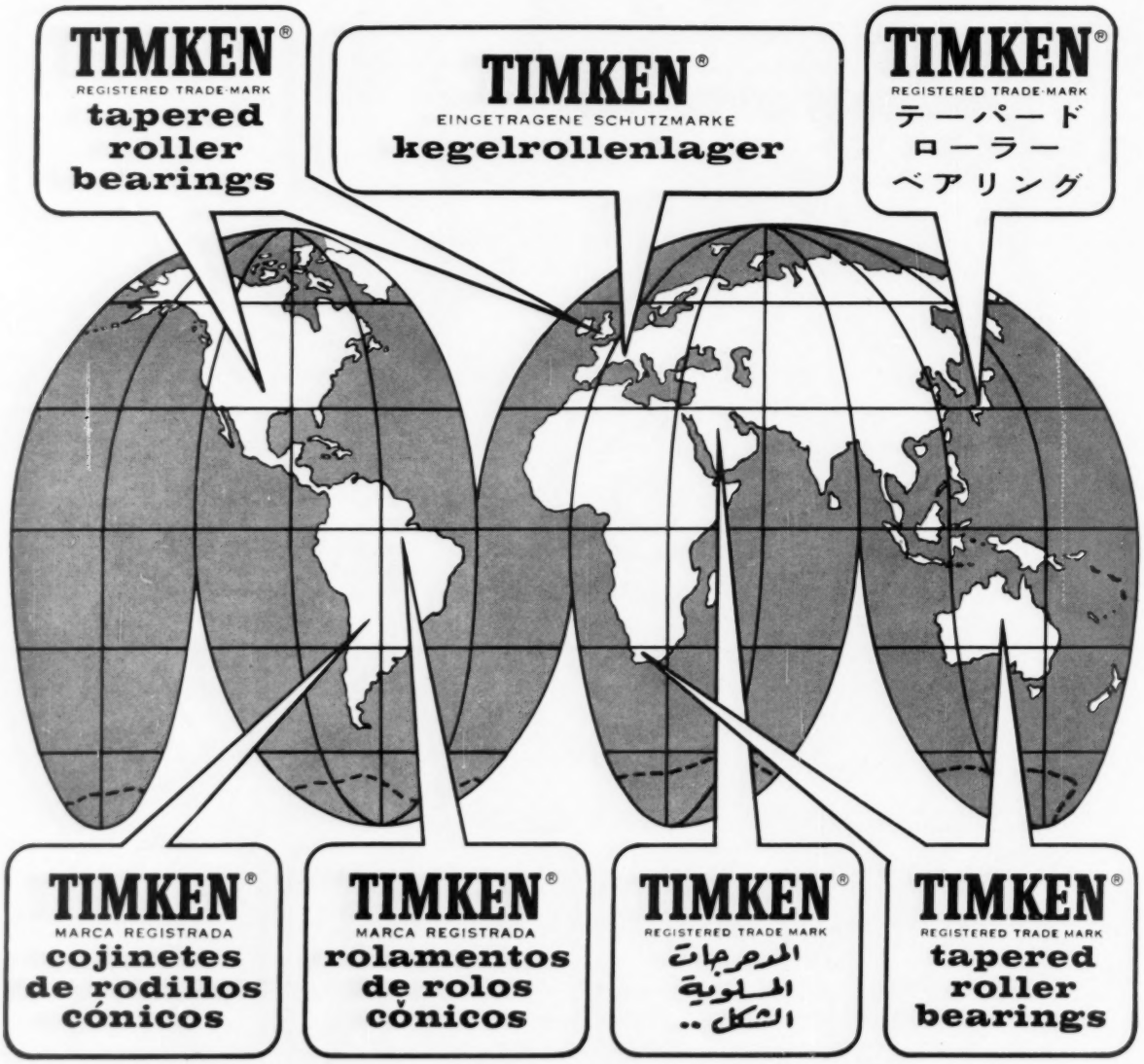

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And when you buy Timken bearings, you're assured of the engineering service of the world's most experienced and largest manufacturer of tapered roller bearings. The name "Timken" is a trade-mark identifying the bearings, steel and rock bits made by The Timken Roller Bearing Company and its subsidiaries and divisions the world over. The Timken Roller Bearing Company, Canton 6, Ohio, U.S.A. Cable address: "TIMROSCO". Timken bearings manufactured in U.S.A., Australia, Brazil, Canada, England and France.